DOCUMENT RESUME

ED 228 793 EC 151 647

AUTHOR	Taber, Florence M.
TITLE	Microcomputers in Special Education. Selection and Decision Making Process.
INSTITUTION	ERIC Clearinghouse on Handicapped and Gifted Children, Reston, Va.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
REPORT NO	ISBN-0-86586-135-8
PUB DATE	83
CONTRACT	400-81-0031
NOTE	109p.
AVAILABLE FROM	The Council for Exceptional Children, Publication Sales, 1920 Association Dr., Reston, VA (Publication No. 248, $7.95).
PUB TYPE	Guides - Non-Classroom Use (055) -- Reports - General (140)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Computer Programs; Decision Making; *Disabilities; Educational Technology; Elementary Secondary Education; *Media Selection; *Microcomputers; Programing; *Special Education

ABSTRACT

Intended for special educators, the book is designed to provide information for assessing classroom needs, making decisions about purchasing software and hardware, and using the microcomputer effectively. Each chapter begins with statements to think about and a list of sources. At the end of each chapter are questions and exercises designed to aid the reader in understanding chapter information. Six chapters cover the following topics (sample subtopics are in parentheses): introduction to the microcomputer (microcomputer languages); software considerations and evaluation (external and internal evaluation of software); hardware considerations and inservice education (peripherals); media selection and microcomputer uses (administrative uses); microcomputer uses in special education; and elementary programing for the microcomputer (program development support). (SW)

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ED228793

Microcomputers in Special Education

Selection and Decision Making Process

U.S. DEPARTMENT OF EDUCATION
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EC151647

CEC A product of the ERIC Clearinghouse on Handicapped and Gifted Children ERIC
The Council for Exceptional Children

Library of Congress Cataloging in Publication Data

Taber, Florence M.

Microcomputers in special education.

Includes bibliographical references.

1. Exceptional children—Education—Data processing.
2. Microcomputers. I Title.

LC3969.T3 1982 371.9'028'5 82-23543

ISBN 0-86586-135-8

A product of the ERIC Clearinghouse on Handicapped and Gifted Children.

Published in 1983 by The Council for Exceptional Children, 1920 Association Drive, Reston, Virginia 22091-1589

The material in this publication was prepared pursuant to contract no. 400-81-0031 with the National Institute of Education, U.S. Department of Education. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their judgment in professional and technical matters. Prior to publication, the manuscript was critically reviewed for determination of professional quality. Points of view or opinions, however, do not necessarily represent the official view or opinions of either the clearinghouse's parent organization or the National Institute of Education.

Printed in the United States of America

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Founded in 1922, The Council for Exceptional Children (CEC) is a professional association committed to advancing the education of exceptional children and youth, both gifted and handicapped.

CEC, with 50,000 members, supports every child's right to an appropriate education and seeks to influence local, state, and federal legislation relating to handicapped and gifted children. CEC conducts conventions and conferences and maintains an information center with computer search services and an outstanding collection of special education literature.

In addition to its membership periodicals, *Educational Children, TEACHING Exceptional Children,* and *Update,* CEC has a publications list of 75 titles including monographs, texts, workshop kits, films, and filmstrips.

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CHAPTER 1

Introducing the Microcomputer

As You Read This Chapter, Think About:

1. *Your perceived needs, as well as the school district's or your organization's needs, that could be at least partially met by the microcomputer.*
2. *What kind of decisions you have to make prior to purchasing a microcomputer and/or to effectively use the microcomputer.*
3. *What a microcomputer is and how it functions.*

INTRODUCTION

As sure as a blizzard can be forecast, the educational forecast for the future is that the microcomputer will be an essential part of every classroom. If used to its capacity, all students will learn at their own individual rates with tasks, concepts, and processes broken down into appropriate steps. Each individual will be able to learn through approaches designed specifically for him or her.

This latter statement has a ring of familiarity for all special educators because we have been trying for years to individualize learning for handicapped persons. The microcomputer can help teachers do just that—totally individualize instruction so that every student is challenged to learn but not frustrated because of being at a failure level. Obviously, just owning a microcomputer will not do all of this for you. The microcomputer is much like the special education student who comes to us because of severe functioning problems. The student must be programmed correctly to produce adequate results. The same is true with the microcomputer: Without the right software and without the right hardware, the microcomputer can do little for us in education.

Therefore, prior to purchasing any microcomputer, your agency must thoroughly assess its needs in order to obtain the maximum benefit from this powerful teaching tool. First, a committee should be formed of those persons who are interested in using the microcomputer. This committee should consider the following questions:

> 1. Who will be in overall charge of the school's computer equipment? ...
> 2. Who will see that all users of the computer(s) are properly instructed in their use? ...
> 3. Where will the equipment be used (and stored)? ...
> 4. Who will make the decision that your computer will need repair and who will take charge of that repair? ... Where will repair monies come from? ...
> 5. Who will investigate sources of computer software? ...
> 6. Who will schedule the use of the computer? ...
> 7. Are there adequate power outlets? ...
> 8. What training will your ... teachers (and staff) have? ...
> 9. Will parents be used to help with the implementation of your program? ...
> 10. What is the purpose of buying a microcomputer for your school? (Chaffee, 1982, p. 76)

This book is designed to help you (a) assess your needs, (b) make decisions about purchasing software and hardware, and (c) use the microcomputer effectively. Every chapter begins with statements you should think about while reading the chapter and ends with a list of sources that can further assist you. At the end of each chapter are questions and exercises designed to assist you in understanding the information that has just been presented. You will learn a little about the microcomputer itself and its functioning, about software and hardware considerations, about instructional and administrative uses for the microcomputer, about uses for the microcomputer in special education, and about some elementary microcomputer programming.

For Discussion

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1. *The microcomputer has the capability of revolutionalizing instruction in the classroom and of providing a tool that can implement one of the most important beliefs in special education. Discuss how this belief could be implemented in special education, in mainstreaming, and in regular education.*
2. *Why is appropriate software the key to implementing this belief?*

THE MICROCOMPUTER: IT'S HERE

In the 1960's, interest flared briefly over devices known as teaching machines. But students quickly tired of these pieces of equipment that called only for simple true-false type responses. In the 1970's, low cost pocket calculators found their way into the classroom. These little machines undoubtedly paved the way for permanently incorporating technology into education. As a result of technological breakthroughs, it is now possible to consider microcomputers as a regular part of teaching technology. The microcomputer goes beyond the teaching machine and the calculator in that it allows the learner to perform complex interaction-type responses. The key word here is interaction because the microcomputer has the capability to analyze learner responses and then react to those responses. In fact, the learner and the machine can communicate with each other.

> The computer is a powerful tool that we're all going to have to learn to use, and that means all of us in education. . . . Technology is not going to take over the job of teaching. But the computer will create a new role for teachers. The teacher won't have to know how to do all of the computing. But he or she will have to be able to give direction. (Shear, 1981, p. 23)

"To be able to give direction" means to use the microcomputer advantageously to reach the primary goal of education—to provide the knowledge and experience necessary for every individual to become a self-sufficient adult. As one of my educable mentally retarded physically handicapped students put it in his high school commencement speech, "I may not become what my classmates may become, but I will be the best man I can." The microcomputer is one of the tools that can help us as special educators provide growth experiences for our learners—to become "the best" they can.

If current trends continue all classrooms will soon have access to microcomputers. It has been projected that within 15 to 20 years students will carry home their own units, plug them into television sets, and complete their homework assignments. The unit could be the size of a looseleaf notebook and have programmed into memory the student's homework assignment—totally individualized.

The direction indicating the availability of microcomputers in every classroom is supported by reports found in a number of sources. For example, Instructor Magazine completed an attitudinal survey on computers in education. Questionnaires were received from 4,000 educators in the fall of 1981. In the first 2,000 received, which closely paralleled the demographics of the country's 1,085,000 elementary educators, "86 percent of respondents expressed a high level of interest in computers personally and perceived the same of others in their schools." ("Computers? You Bet I'm Interested," 1982, p. 76). Of the 2,000, 39% indicated they used computers for instruction. Of the 1180 who did not use computers for instruction, 68% indicated they did not have access to them.

Why the interest in computers, or the small computer called the microcomputer? The microcomputer can test and analyze the results of tests; individualize instruction with an appropriate task analysis and presentation for the individual; organize, analyze, and present material; store material, test results, etc., in memory; and develop problem-solving abilities. The microcomputer has infinite patience, can objectively individualize and yet interact with the student on a first name basis, and can keep track of the student's progress. It can be invaluable in the Individualized Education Program (IEP) process as it assesses the student, determines goals and behavioral objectives for the student, stores as well as transfers the IEP wherever it is necessary, and provides copies for all appropriate persons.

As a side benefit, it will force educators to learn more about how humans think. In analyzing how the computer "thinks," teachers will learn more about the thinking process itself.

For teachers, learning about the computer is a *must* so that the microcomputer can be a tireless teacher's aide. Learning about computers is a *must* because "microcomputers themselves are useless unless they are accompanied by appropriate educational programs or software" (Hannaford & Sloane, 1981, p. 55). Learning about computers is a *must* if we as special educators are going to maximize the development of handicapped persons in order to help them control and/or alleviate their handicaps (Joiner, Sedlak, Silverstein, & Vensel, 1980).

What does "learning about computers" mean? It means becoming computer literate. There are many definitions for computer literacy, ranging from those that are as simple as "to understand computers" to those that are not only precise but involve an advanced degree in computer science. For our purposes, computer literacy will involve "the history, operation, and applications of computers, as well as the social, psychological and vocational impact of computer-based technology" (Thomas, 1980, p. 1).

What does all this mean? Let us first refer to the general definition of literacy. To be literate, one must be able to read and write, be able to understand, and be able to have command of the language. Therefore, to be computer literate, the educator must understand what the microcomputer can do by gaining knowledge of the development of the microcomputer, its component parts, how it works, why it does whatever it does, and the social and psychological implications of its uses. Then the educator can learn enough of "the language" to be able to tell the machine what to do. The educator must be able to understand what the computer is saying (for example, when it says "syntax error") and then to "speak" the same language in written form to make the machine "understand" and respond as desired. Computer literacy, like any other literacy, is not an absolute but is on a continuum. With the computer revolution-evolution moving at an ever increasing rate, becoming relatively computer literate will take continued effort on the part of the educator. Computer literacy cannot be taught in one course or one inservice presentation. Someone who is computer literate today but fails to continue expanding his or her knowledge, will rapidly become computer illiterate.

How literate are you? The Minnesota Educational Consortium's Computer (MECC) Literacy Project has developed a comprehensive set of objectives for the cognitive and affective domains. These objectives as well as a copy of their "Computer Literacy Concept" bibliography are valuable tools to assess your own skill level (see Sources for Further Information).

For Discussion

1. *Why is "interaction" an important function of educational programs for the microcomputer?*
2. *How would you define "computer literacy" as it relates to your professional needs?*
3. *Where are you at the present time on the continuum toward computer literacy and what is your plan for advancing further?*

WHAT IS A MICROCOMPUTER?

A microcomputer is first of all a computer, and a computer is a machine (called hardware) that follows directions. The microcomputer stores, compares, changes, and manipulates information according to a set of instructions called a program (software). These programs are written in language or code which can be interpreted by the machine.

When we as special educators analyze our students, we do so in terms of input, process, and output. The microcomputer can be analyzed the same way: the major parts of the computer are referred to as parts that input, process, or output information (see Figure 1).

First, information is fed into the microcomputer. If we are developing our own program, we input information into the computer's "brain"—called the central processing unit (CPU)—by typing on a keyboard that is usually organized like a typewriter keyboard. If we input information that has already been programmed, called software, we do so through a disk drive, tape recorder, or program cartridge. If our microcomputer has a disk drive, the preprogrammed input is on a disk; if we have a tape recorder, the program is on tape. If the selected computer can accept program cartridges, we may purchase cartridges that slide into a cartridge holder.

Output is usually viewed and comes in one of two forms. Often a television or video monitor is hooked up to the microcomputer so that the user can see the program "input" and the results of the processing of that program. The second major device for output is the printer, which provides a hard copy or printout of information as requested through the CPU. Information can also be received via a voice synthesizer.

FIGURE 1.
Microcomputer functioning.

INPUT ——→	**PROCESS** ——→	**OUTPUT**
External Memory: Disk Drive Tape Recorder Cartridge Immediate Communication: Keyboard Joysticks, etc. Voice Control	Central Processing Unit (CPU) Internal Memory: ROM PROM EPROM RAM	Display Monitor Television Printer Voice Synthesizer CRT Terminal

Information is processed through the CPU. It is important to remember that the CPU does only what it is told to do by a program. For example, special programs can allow the CPU to translate other programs from external memory (i.e., disk, tape, or cartridge) into a language form that the computer can manipulate (machine language). It can also receive information from the keyboard or in some instances from voice command.

Memory can be discussed in terms of both external and internal memory. External memory defines how large a program can be in order to be stored on a tape, disk, or cartridge (i.e., disk capacity). Internal memory "determines how much information the computer can store and manipulate" at one time (Taber, 1981, p. 2). Internal memory is a transient memory with specific addressable locations. "Each memory location can store either an instruction to the microprocessor or an item of information to be processed" (Prentice, 1981, p. 90).

The terms *bit* and *byte* are used when discussing memory. Computers process information in the form of a series of on/off signals. A bit is the smallest piece of information (one on or off signal to the computer). A byte (usually 8 bits) is the smallest information unit and represents a letter, number, or symbol.

Memory capacity is measured in K's: 16K, 32K, 48K, 64K, etc. One K equals 1,024 bytes and generally refers to the number of bytes that can be stored in the computer at one time. For example, when a program on a disk is too large to enter internal memory at one time, the computer reads from the disk a part of the program and then, by command, returns to the disk to get or load the next segment of the program.

Other important terms used to describe internal memory are ROM, PROM, EPROM, and RAM. ROM means read only memory which is preprogrammed memory permanently located within the computer. It cannot normally be changed. ROM often includes the machine language system routines (routines that allow the CPU to communicate with input and output devices). PROM means programmable read only memory, which is memory that can be programmed by the user. Like ROM, it cannot normally be changed once programmed. PROM often includes custom programs, such as a routine to communicate with a special peripheral not normally connected to that computer. EPROM (erasable programmable read only memory) is like PROM, except its programs can be erased by exposing the memory chip to ultraviolet light. The chip can then be reprogrammed.

Another type of memory is RAM. RAM means random access memory, which can be programmed, reprogrammed, or edited. Examples of RAM include the space available for the operation of programs and the creation of new programs. You may hear this term used in connection with the purchase of a memory chip—which can extend your computer's capabilities. A word of caution here: If you ever consider the purchase of memory chips, obtain advice from a person who understands what chips are compatible with your machine, with your system's power supply, and with the memory already present (Schneider, 1981).

You should be familiar with one additional term to understand the basics of the microcomputer—peripheral. A peripheral is any extra equipment that you can add on or attach to your microcomputer. A printer is a peripheral. Joy sticks and control knobs, used with many of the popular computer games, are peripherals. Light pens are peripherals that can be used by physically handicapped individuals to interact with the computer. Another "add-on" is a speech synthesizer that can be especially helpful to persons with visual or reading impairments. Another peripheral that has previously been used on main frame computers and is now being used on microcomputers is the MODEM. A MODEM, or MOdulator/DEModulator, connects one computer to another over telephone lines, transforming computer language to audio signals and back to computer language at the other end.

For Discussion

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1. *Define the following as they relate to the microcomputer:*
   - *Hardware*
   - *Software*
   - *CPU*
   - *Printer*
   - *PROM*
   - *Keyboard*
   - *Memory*
   - *Program Cartridge*
   - *ROM*
   - *EPROM*
   - *Peripheral*
   - *RAM*
   - *MODEM*
   - *Tape Recorder*
2. *What are the major parts of the microcomputer and how does each relate to input, process, and output?*
3. *What is computer memory and why is it important when learning about the microcomputer?*
4. *Name three types of external memory on which information may be stored.*
5. *Explain bit, byte, and K as they relate to memory.*
6. *What are the primary means of output for the microcomputer?*

7. *Why is the availability of peripherals of great importance to the special educator?*

MICROCOMPUTER LANGUAGES

As mentioned earlier, humans communicate with computers through a language that is understood by that computer. Many microcomputers speak a language called BASIC (Beginner's All-purpose Symbolic Instruction Code). However, the "dialect" in BASIC for one microcomputer is not necessarily understood by other microcomputers. This fact is especially important to remember because software created in BASIC for one microcomputer may not work on another microcomputer that understands BASIC. For example, software created for the Apple probably will not run (work) on the Atari, or vice versa. The importance of understanding this incompatibility will be further explained in the next chapter.

The language educators need to be most familiar with is BASIC. BASIC was created for the novice programmer in order to make programming as simple as possible. BASIC is similar to the English language. You may also hear the term authoring language or authoring system. An authoring language is a language distinct from other languages. Some authoring systems generate programs which run under BASIC. Chapter 6 presents more information about BASIC and authoring languages and systems. At this point in the text, be comforted in knowing microcomputers come with manuals that provide elementary instruction in the specific language(s) designed for that machine.

There are, of course, other languages used in programming computers. Each one is designed with a particular purpose in mind. For example, FORTRAN (FORmula TRANslator) is designed primarily for the math/science field, and COBOL (COmmon Business Oriented Language) is designed for college students and the business field.

Most languages include a special section of programs which allows the CPU to translate that language into a machine language. Machine language is a set of binary codes which can be interpreted by the CPU to cause its internal circuitry to be charged to perform the specified functions. Some professional programmers program directly in machine language but this requires advanced study in computer programming. However, since programming directly in machine language requires less memory than other languages, such as BASIC, machine language is sometimes used by software companies whose programs are long and complex and require extensive memory.

For Discussion

1. *What is computer language and why does the educator need to understand computer languages and their functions?*
2. *Why is it important to know what language or dialect of a language specific computers understand?*
3. *What is the most popular computer language used in programming educational software?*
4. *What is machine language?*

SUMMARY

Chapter 1 has introduced the reader to the microcomputer by providing background information on the development and use of the computer, by discussing the major parts and elementary functioning of the microcomputer, and by introducing computer languages and their functions. The next two chapters provide information that will help the reader determine the importance of increasing his or her computer literacy regarding software and hardware evaluation, prior to purchasing the first microcomputer or in the continuing use of microcomputers.

For Further Discussion

1. *What is computer literacy?*
2. *Why is growth in computer literacy important prior to purchasing microcomputers?*
3. *Should purchasers of hardware be proficient in computer programming? Defend your answer.*
4. *What facts about the microcomputer and its functions do you consider important for the educator to understand and why?*
5. *How can the microcomputer assist the special educator?*

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CHAPTER 2

Software Considerations and Evaluation

As You Read This Chapter, Think About:

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1. *Why one must consider software and hardware evaluation and inservice training before purchasing microcomputers.*
2. *Why the evaluation of software is especially important to the purchaser and the user of the microcomputer for educational purposes.*
3. *How to establish a method of evaluating software and what should be included on any form used for this purpose.*
4. *How both external and internal evaluation of software can be beneficial in the decision-making process both prior to purchasing a microcomputer and in using the microcomputer effectively.*
5. *How to establish a means within your school system/university to determine the needs a microcomputer could meet.*

IMPORTANCE OF SOFTWARE EVALUATION

Chapter 1 introduced the microcomputer. This chapter and the next provide information that will assist in purchasing microcomputers for educational purposes. The considerations covered are a *must* if the microcomputer is to become an educationally effective tool in the classroom and a cost-effective item to purchase.

Three major considerations are covered in these next two chapters: software, hardware, and inservice training. Software consideration will be covered first because it is the most important. Hardware and inservice training are covered in Chapter 3.

"The first step in selecting a computer is defining just what you need it for" (Frenzel, 1981, p. 44). Most of us have some general idea why we want to purchase a microcomputer—to instruct students, to keep records, or to teach programming. However, we really need to be much more specific than that. We need to create a list of planned uses and then to rank them in order of importance.

Since the concept of using the microcomputer is relatively new and since we want our purchase to be cost-effective, *all* persons who will have the opportunity to use this machine should be asked to provide input. Often a school system puts one or two persons in charge of computers for the district. This person(s) is expected to investigate and purchase computers and to provide inservice education to the staff. In order for the microcomputer to be accepted by the staff and faculty, they need to be involved in the investigation, selection, and implementation process. Furthermore, if this process is carried out by a group, one idea/need will stimulate others—especially if the group is not computer literate. After an initial list of needs is created, the group should be encouraged to think about further uses and learn more about the capabilities of this machine by reading computer magazines; by attending workshops developed by commercial companies, local education authorities, universities, and user groups; by visiting computer stores to talk to salespersons and view programs; by talking to persons who have experience with computers; and by joining user groups and national associations.

When the list of uses is relatively complete, it is time to investigate existing software and hardware. Software is hardware specific. That means any given program can only be used on the machine it was created for. Therefore, prior to determining what hardware meets your specific needs, a search of effective educational software must be undertaken. This chapter will help you investigate the area of software.

Some of you may be thinking that this consideration is not important to you because you would like to create your own software. That is fine: (a) if you have the technical expertise, (b) if you have the time, and (c) if you have the financial backing, because release time from teaching will probably be necessary if you plan to create high quality, educationally effective programs. On the other hand, you will probably want to do at least some of your own programming. However, quality programs beyond simple drill and practice get quite complicated and most educators initially do not have the necessary expertise to program software.

As you gain experience you will probably want to modify programs or create software that is appropriate to your educational needs. Much of the software on the market today is not educationally effective since much of it was created by computer technologists who know little, if anything, about educational principles. However, some commercial companies and school systems have hired persons with both educational and technological expertise to develop programs that are based on educational principles and that use the microcomputer's capabilities effectively.

The time factor is also a deterrent to creating one's own programs. Educationally sound and technically correct programs can take up to 1,000 hours to create, and most educators lack the necessary time.

The amount of money needed to create effective software is another factor to consider in developing effective programs. Gleason (1981) pointed out that "production of high-quality programs is expensive; $10,000 per instructional hour is not unrealistic" (p. 12).

When one adds to the previously mentioned factors the fact that programs are not only language specific but machine specific, software evaluation prior to purchasing a microcomputer takes on a new importance. Remember, a program designed for a specific machine, like an Apple II, may not run on other microcomputers such as the Atari. Therefore, *it is very important that effective software availability be considered before purchasing any hardware*. Naturally, evaluation should also occur prior to purchasing software. The importance of this pre-purchase evaluation cannot be stressed too greatly. Many educators have bought microcomputers based on hardware alone—only to have them take their place beside other dust-collecting items because effective programs were lacking. Holznagel, Past-President of the National Association for Educational Data Systems (AEDS) and Coordinator of Microcomputer Software and Information for Teachers Clearinghouse of the Northwest Regional Educational Laboratory, verified this lack of effective software programs. He indicated that most software programs, especially those that originate in the classroom, are poorly designed, are poorly implemented, do not run to completion without a problem, and lack clear objectives (Isaacson, 1981).

For Discussion

1. *What are the tasks a microcomputer could perform in your school system/university to meet specified needs?*
2. *Who should be involved within your school*

system/university in determining the probable uses of the microcomputer and why?

3. *What are some reasons why it is unwise to purchase a microcomputer without investigating/evaluating software first?*
4. *What are some reasons why it is difficult to do all of your own programming if you are primarily in the educational profession as a teacher, administrator, aide, etc.?*
5. *What skills might be appropriate for the person in charge of educational microcomputer program development?*

EXTERNAL EVALUATION OF SOFTWARE

Microcomputer software evaluation can be external, based on evaluation from outside sources, or internal, based on your own or your school system's evaluation. Both types of evaluation will be discussed because both should be employed to make appropriate selections. It should be kept in mind that as problems, or glitches, are discovered in software, revisions are made by the publisher. The implications of this are that evaluators' criticisms may no longer apply to the program currently being sold.

Whenever external evaluations are considered, a number of questions need to be addressed as to the validity and reliability of those evaluations:

1. Are you considering the same version of the program that was reviewed?
2. Does the evaluator have educational credibility?
3. Does the evaluator have technological credibility?
4. Is the evaluation limited as to its subjectivity?
5. Was the program considered for an audience with needs similar to the audience for which the program is intended?
6. Was the audience considered in the evaluation similar to the one that will use this program in this school system/university?

The second and third questions are meant to ascertain whether or not the evaluator has both educational and technological credibility. The evaluator should understand educational principles and have extensive teaching experience or be otherwise educationally associated with the audience for which the program was designed. The fourth question addresses subjectivity. To limit subjectivity, several evaluators should independently evaluate the program. The results should be based on that which is consistently found between two or more of these evaluators. The fifth and sixth questions address the audience considered in the evaluation and its similarity to the audience that would be using the program. A program designed for one audience may not be appropriate for another audience. Certainly, the evaluation should clarify the group for which the program was judged—by age, ability levels, handicapping conditions, and so forth.

Holznagel (1981) indicated that "most current efforts at evaluation are characterized by a narrative review written by one person, published in a magazine or journal . . . [and that] criteria and approach usually vary with evaluators and publications" (p. 38). He further stated that evaluations should follow a "consistent procedure and set of criteria" (p. 38).

One example of a model that addresses evaluation of software using a "consistent procedure and set of criteria" is the MicroSIFT Model from the Computer Technology Program of the Northwest Regional Educational Laboratory (Holznagel, 1981). MicroSIFT was designed to be a clearinghouse for microcomputer software and has as "one of its goals the development and implementation of an evaluation process and related instruments for educational courseware" (Jostad, 1982, p. 25). This model follows four general stages of evaluation: (a) sifting, (b) description, (c) peer evaluation, and (d) in-depth evaluation.

The first stage, sifting, simply determines whether or not a program will be considered. No determination of quality is made at this point.

The second stage, description, identifies information such as specific topic, grade and ability level, [and] required hardware. Instructional techniques, behavioral objectives, and prerequisite skills are also identified here.

During the third stage, peer evaluation, the educational value and instructional quality of the software are determined by peers or teachers whose experience is in the subject area and grade or ability level of the package. These teachers must also have experience using computers in the instructional process.

The fourth stage, in-depth evaluation, includes pretest and posttest observations and other techniques used for evaluation. Since this last step is both time-consuming and expensive, it has not been implemented completely. However, it is very important and, at least as far as commercial products are concerned, should be conducted in the form of field study. Few companies have carried out intensive field studies and fewer yet have those studies available to the consumer. However, the studies that are available can provide valuable information in addressing the five evaluation questions listed earlier in this section.

Some companies, such as CONDUIT, that review and distribute materials developed by others, follow a multistep process throughout the developmental process of creating software. When CONDUIT receives a program from an author, the staff conducts an initial screening stage to evaluate both the program and the documentation. Many programs are rejected during this initial stage. CONDUIT's second stage involves extensive review by at least two editors with appropriate credentials. A Multi-Section Review Rating Form is initiated during this stage, covering program description, substantive content, documentation, support for the teaching process, stimulation and interest, and computer techniques. The third stage completes the form, identifying specific strengths and weaknesses. The fourth stage recommends improvements and works out an improvement plan with the author. During the fifth stage, the program is technically tested (Peters & Hepler, 1982).

Many other sources are available from which the reader can obtain information on the external evaluation of software, some of which are listed at the conclusion of this chapter.

For Discussion

1. *Define external and internal evaluation as it relates to microcomputer software and the decision making process.*
2. *What are the five questions that should be considered when determining the validity and reliability of external evaluation and what do they mean?*
3. *Discuss the MicroSIFT evaluation model in regard to your needs—considering the stages of sifting, description, peer evaluation, and in-depth evaluation.*
4. *What would you hope to find in a field study report and why should extensive field study be a part of all developmental models of software?*

INTERNAL EVALUATION OF SOFTWARE

Internal evaluation of software involves the evaluation of software from within a school, school system, or university. This type of evaluation should occur not only prior to the purchase of any software but, as indicated previously, prior to the purchase of hardware. Often this is not as simple as it appears. First of all, it is difficult to get software to preview because of the producers' fear of having their programs copied and then freely distributed. Since publishers invest large sums of money in developing software, they rarely allow entire programs to be previewed. However, some publishers have "demos," or sample programs, they will send out for a specified time. Second, many prospective buyers do not know how to evaluate software. Educators do know, or should know, educational principles upon which to evaluate software. However, few of them know the capabilities of the microcomputer and how to evaluate technical adequacy.

Hannaford and Sloane (1981) have conducted extensive research on selecting software for handicapped students. They indicated that "we must identify and use systematic criteria that will allow us to wisely select software that meets learner/teacher needs, has instructional integrity, and is technically adequate and usable" (p. 54). Questions concerning learner/teacher needs focus on appropriate content to meet goals and objectives, and appropriate methods of presentation based on individual learning styles. Questions concerning instructional integrity examine the educational principles upon which the program is based and the selection of appropriate learning modes.

MCE Inc. produces software primarily for special needs learners at the secondary to adult level. MCE includes an evaluation form with each program and invites purchasers to evaluate their programs as well as other microcomputer software not produced by MCE. Although organized differently from the questions outlined by Hannaford and Sloane, the content of the MCE Evaluation Form is similar. Figure 2 is a modified version of this evaluation form.

The MCE form was modified to allow the reader to evaluate and compare up to four programs on one form. Each of the variables listed is rated on a 5-point scale. The scores may be totaled to assist in determining which program most closely meets the needs of the evaluator.

The Modified MCE Evaluation Form is divided into four sections: (a) instructional content, (b) educational adequacy, (c) technical adequacy, and (d) overall evaluation. Questions regarding instructional content cover the following areas: goals and objectives; data to be used in individualized education programs (IEPs); prerequisite skills/concepts listed; paraphrasing of or defining of new vocabulary; the documentation or instructional guide and its value in assisting the instructor in implementing the program; and other questions regarding the presentation of materials, such as content, type of presentation, and concrete examples.

The second section, educational adequacy, covers principles based on educational theory and program design. Educational theory questions cover use of reinforcement theory; logical communication between the computer and the student; use of music, graphics, and other aids

FIGURE 2.
Modified MCE Program Evaluation Form.*

DIRECTIONS: This evaluation form is designed to evaluate four software programs. Answer each of the questions about each program you evaluate. Use the following rating scale:

3 = EXCELLENT
2 = ABOVE AVERAGE
1 = AVERAGE
−1 = BELOW AVERAGE
−5 = POOR

After rating programs in each area, add up the total scores and place them in the appropriate spaces. Let this rating help you in your decision making in the purchase of microcomputer software.

NAMES OF PROGRAMS EVALUATED:	**TYPE OF PROGRAM EVALUATED** (i.e., tutorial, etc.)
1. ______________________	______________________
2. ______________________	______________________
3. ______________________	______________________
4. ______________________	______________________

COMMENTS ON EACH PROGRAM:

1. ____
____
2. ____
____
3. ____
____
4. ____
____

PROGRAM CHOICE (if applicable): ______________________
____

Continued on next page.

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*Special thanks to MCE Inc. (157 Kalamazoo Mall, Suite 250, Kalamazoo MI 49007) for the use of this form.

FIGURE 2 continued

	PROGRAM NAMES			
	1	2	3	4
I. INSTRUCTIONAL CONTENT				
1. Is the content consistent with the goals and objectives of the program?				
2. Is the program one of a series in which carefully planned learning objectives have been followed?				
3. Does the Instructional Guide provide information, suggestions, and materials to assist the teacher in successfully implementing the program?				
4. Are program goals provided that are usable for individualized education programs?				
5. Are evaluation materials and/or criteria provided that are usable for individualized education programs?				
6. Are prerequisite skills, vocabulary, and concepts determined and presented?				
7. Is vocabulary defined or paraphrased in text or in the prerequisite skills portion of the Program Principles Section of the Instruction?				
8. Are diagnostic or prescriptive procedures built into the program?				
9. Does the text follow established rules for punctuation, capitalization, grammar, and usage?				

Continued on next page.

FIGURE 2 continued

	PROGRAM NAMES			
Instructional Content con't.	**1**	**2**	**3**	**4**
10. Are supplemental materials provided for learner and teacher?				
11. Is the product designed for appropriate age and ability groups?				
12. Is the program compatible with the curriculum?				
13. Is the program compatible with the needs of the teacher?				
14. Is the content accurate and complete?				
15. Are examples provided with directions when appropriate?				
16. Are redundancy and drill used effectively?				
17. Is language appropriate in tone and selection?				
18. Are concrete applications for concepts provided?				
19. Is feedback immediate?				

II. EDUCATIONAL ADEQUACY

1. Is instructional design of high quality using accepted learning theory?				
2. Are learners always the target of interaction with the computer—a personalized element?				
3. Are positive responses reinforced?				
4. Are frames that follow incorrect responses nonpunishing?				

Continued on next page.

FIGURE 2 continued

Educational Adequacy con't.	**PROGRAM NAMES** **1**	**2**	**3**	**4**
5. Is reinforcement variable and random in context and established by behavior management principles?				
6. Is branching used where the learner demonstrates need for further concept development before proceeding?				
7. Are avenues of communication from the learner to the computer logical and at comprehensible levels?				
8. Is evaluation of each concept appropriate and sufficient?				
9. Are concepts and skills task analyzed into appropriate steps?				
10. Are color, graphics, and animation used effectively to enhance the lesson?				
11. Are sound, inverse print, etc., employed for attention and reinforcement purposes and not distracting?				
12. Is syllabification provided for new and/or unfamiliar words?				
13. Is sentence length dependent on need and learner levels?				
14. Is the learner always provided with frames that allow for progression through the program?				
15. Does the program provide suitable directions for the learner?				

Continued on next page.

FIGURE 2 continued

	PROGRAM NAMES			
III. TECHNICAL ADEQUACY	**1**	**2**	**3**	**4**
1. Will the program run to completion without being "hung up" because of unexpected responses?				
2. Are the programs difficult or impossible to be inadvertently disrupted by the learner?				
3. Can learners operate the programs independently?				
4. Is the amount on each frame appropriate?				
5. Is the length of each section appropriate?				
6. Are words and lines spaced for ease of reading?				
7. Is variation of type and organization of textual materials appropriate for a clear presentation?				
8. Are inappropriate responses considered and handled appropriately?				
9. Is the educational technology (i.e., microcomputer) the best available for presenting this subject matter?				
10. Are backups available?				
IV. OVERALL EVALUATION RATING OF PROGRAM IN ITS ENTIRETY				
TOTAL FOR EACH PROGRAM				

that assist in teaching; syllabification of unfamiliar words, sentence length and placement of text on the screen, appropriate program length, and appropriate interest level; and use of branching to individualize to appropriate conceptual and reading levels as well as breaking the concept into smaller steps.

These latter questions are designed to make maximum use of computer technology. Many programs on the market do not branch to different levels of presentation although they do employ elementary branching. For example, if a student response is incorrect, the student goes through the same frames again and the concept or skill is re-presented exactly the same way it was the first time. If the student did not understand the presentation the first time, chances are he or she will not understand that presentation the second time either. The importance of evaluating the instructional adequacy of programs cannot be stressed too much. Some programs may be technically adequate but lack the educational input. This is evidenced by programs that leave learners caught on a specific frame in the program because there are no available directions to instruct the user in how to proceed or by programs that print "DUMMY" across the screen whenever an error is made. Another example of lack of use of educational theory was seen in a program where, if errors were made, an exciting explosion occurred, which could reinforce the making of errors.

Questions in the technical adequacy section of the Modified MCE Evaluation Form address technical effectiveness. One question asks if the program runs to completion with no error messages regardless of the student responses. (Error messages are computer messages that indicate a programming or input error that stops the program from running to completion.) Other questions address whether the program is personalized and can be independently run by the student. An additional question asks if the microcomputer is the most appropriate medium for presenting the subject matter. This subject will be covered more thoroughly in Chapter 4.

The fourth section deals with the overall evaluation of the program, which is a general impression of the product as a whole. This section is followed by a space provided for comments and a place to check off the category the program falls into (e.g., drill and practice, problem solving, tutorial, or instructional).

If an extensive evaluation form is not practical for the user, a short form such as the one presented in the October issue of *Instructor Magazine* ("This Month Instructor: Classroom Computer News," 1981) could be used. This form is actually a card that includes program name, source, price, subject, type, description, remarks, level (K–12), and rating. The previewers' names and categorizing information are also included on the card.

Each school system/university should design its own method of evaluation based on its specific needs assessment. For example, the information on the card evaluation example could include reading and interest levels, peripherals necessary or available, and other pertinent information required for special education. Software evaluation is an ongoing process, whether it is carried out as a part of the decision-making process in the initial purchase of the microcomputer or in the yearly purchase of software. Therefore, an organized method for cataloging information is necessary.

For Discussion

1. *Why is internal evaluation an important part of the decision-making process regarding software?*
2. *What learning principles appear to be especially "implementable" using the microcomputer?*
3. *How can the microcomputer be used to individualize the presentation of content?*
4. *How would you organize evaluation information about software?*

SUMMARY

Chapter 2 was the first of a two-chapter series providing evaluation information to assist in the purchase of the microcomputer. The three areas of consideration—software, hardware, and inservice training—were mentioned as necessary in order to make appropriate and cost-effective decisions. Because educationally effective software is limited and because the software that is available is usually machine specific, evaluating software is of utmost importance prior to purchasing any microcomputer. This point cannot be stressed too strongly. Because of the importance of software evaluation prior to purchasing a microcomputer, this entire chapter has been devoted to the external and internal evaluation of software—external evaluations being those provided by agencies, magazines, and organizations; internal evaluations being those carried out within individual school systems/universities.

Activities and Further Discussion

1. *Create a list of the needs a microcomputer could meet within your system/university. Be sure to leave space for additional ideas.*
2. *Create a form or card that would be useful within your system/university on which software evaluation information could be stored (being aware that after purchasing a microcomputer, this information could be stored in a program).*
3. *Use an evaluation form (either one created by someone else or by you) to evaluate examples of software. Discuss your evaluation with a group, remembering to evaluate both educational effectiveness and technical adequacy.*

SOURCES OF FURTHER INFORMATION

Organizations

The Apple Foundation, Journal of Courseware Review, 20525 Mariani Ave., Cupertino CA 95014

Association for Educational Data Systems, 1201 16th St., NW, Washington DC 20036

CONDUIT, PO Box 388, Iowa City IA 52240, Phone: 319-353-5789

Dataspan, Karl Zinn, Director, University of Michigan, Ann Arbor MI 48109

Dresden Associates, PO Box 246, Dept. CN-1, Dresden ME 04342, Phone: 207-737-4466

Educational Software Exchange Library (EDSEL), % Stanford Avenue School, 2833 Illinois Ave., Southgate CA 90281

E.P.I.E., SUNY, Stonybrook, PO Box 620, Stonybrook NY 11794

International Council for Computers in Education, Department of Computer and Information Science, University of Oregon, Eugene OR 97403, Phone: 503-686-4414 or 686-4429

JEM Research, Discovery Park, University of Victoria, PO Box 1700, Victoria, BC V8W 2Y2

MACUL (Michigan Association for Computer Users in Learning), % Wayne County Intermediate School District, 33500 Van Born, Wayne MI 48184

Materials Review and Evaluation Center, Computer Courseware Project, Division of Educational Media, State Department of Public Instruction, Raleigh NC 27611

MECC Users Newsletter, 2520 Broadway Dr., St. Paul MN 55113, Phone: 612-376-1117

Microcomputer Resource Center, Teachers' College, Columbia University, Box 18, New York NY 10027

MicroSIFT News, MicroSIFT Project, Northwest Regional Educational Laboratory, 710 SW 2nd Ave., Portland OR 97204

Minnesota Educational Computing Consortium (MECC), 2520 Broadway Drive, St. Paul MN 55113

"Guidelines for Evaluating Computerized Instructional Materials," National Council of Teachers of Mathematics (NCTM), 1906 Association Drive, Reston VA 22091

Software Directory, Robert Elliott Purser, PO Box 466, El Dorado CA 95623

The Computing Teacher, International Council for Computers in Education, Eastern Oregon State College, La Grande OR 97850

Technical Education Research Center, 8 Elliott St., Cambridge MA 02138

TRACE Research and Development Center, University of Wisconsin, 314 Waisman Center, Madison WI 53706

Companies with Field Study

MCE Inc., 157 S. Kalamazoo Mall, Suite 250, Kalamazoo MI 49007

Random House, Inc., School Division Systems, 400 Hahn Rd., Westminster MD 21157

Computer Journals

AEDS Journal, 1201 16th St., NW, Washington DC 20036

AEDS Monitor, St. Paul Public School, 360 Colborne St., St. Paul MN 55102

Apple ED News, 10260 Bandley Dr., Cupertino CA 95014

BYTE, 70 Main St., Peterborough NH 03458

Classroom Computer News, Box 266, Cambridge MA 02138

Compute, Box 5119, Greensboro NC 27403

The Computing Teacher, Computing Center, Eastern Oregon State College, LaGrande OR 97850

Creative Computing, PO Box 789-M, Morristown NJ 07960

Educational Computer, PO Box 535, Cupertino CA 95015

Electronic Learning, 902 Sylvan Ave., Englewood Cliffs NJ 07632

InfoWorld, 530 Lytton Ave., Palo Alto CA 94301

Microcomputer News, Benwill Publishing Corporation, 1050 Commonwealth Ave., Boston MA 02215

Microcomputing, Elm St., Peterborough NH 03458

Popular Computing, 70 Main St., Peterborough NH 03458

Personal Computing, 1050 Commonwealth Ave., Boston MA 02215

Softalk, Softalk Publishing, Inc., 10432 Burbank Blvd., North Hollywood CA 91601

Sources of Lists of Software Companies

Brady, H., & Harkavy, M. Where to look for what kind of software. *Educational Dealer*, January 1982, 26–28.

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Isaacson, D. What's holding back computer use in education. *Classroom Computer News*, 1981, *1* (5), 1; 28–29.

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Taber, F. The microcomputer—Its applicability to special education. *Focus on Exceptional Children,* 1981, *14*(2), 1–14.

This month instructor: Classroom computer news. *Instructor,* 1981, *41*(8), 85–96.

Wilson, K. Managing the administrative morass of special needs. *Classroom Computer News,* 1981, *1*(4), 8–9.

CHAPTER 3

Hardware Considerations and Inservice Education

As You Read This Chapter, Think About:

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1. *What are your hardware needs? What peripherals would be effective as an aid in the educational process of handicapped students in your school system/district? As an aid in the execution of administrative duties?*
2. *What are the inservice needs for you and/or your staff to organize and implement uses for the microcomputer?*

INTRODUCTION

Chapter 2 discussed software evaluation as the primary consideration in selecting the right microcomputer to meet your specific needs and those of your system. Two remaining considerations will be covered in this chapter. The first of these considerations concerns hardware or the actual microcomputer you might select. The second deals with inservice training, which, although not absolutely necessary, can be helpful in making a final decision. Inservice training involves education in the uses of the microcomputer, the operation of the machine, and possibly programming.

HARDWARE CONSIDERATIONS

Since software is at present computer dependent, it is imperative that the microcomputer you select meet as many software needs as possible. While larger districts may be able to afford several kinds of microcomputers, smaller districts should select fewer types of microcomputers so that software can be shared. Other needs that should be considered in purchasing microcomputers, such as the potential for expansion of uses and cost-effectiveness, are covered in detail in this chapter.

Hardware evaluation is a complex task. Chapter 2 suggested listing your computing needs. Based on these needs, a hardware evaluation chart of desired options can be constructed. Be sure to leave enough space where the columns and rows intersect to indicate the following:

1. Is this option available?
2. Is it part of the package when the microcomputer is purchased or is it considered an extra?
3. How much does it cost?
4. What other information will help to make a decision?

Figure 3 shows the beginning of such a chart. The example in Figure 3 answers the four previous questions, indicating (1) this option is available on the Apple II, (2) it is not part of the initial package, (3) it costs "X amount" to purchase, and (4) it is useful for collecting and storing information. If one of the four questions is not applicable, NA could be printed or the space could be left blank. An article written by Wood and Wooley (1980) sets up a chart similar to this one. The reader may wish to refer to it for information on completing a chart.

Other areas determined desirable in this assessment can be noted across the top of the chart. For example:

1. *Price of the Basic Computer.* The basic price covers the components that are included with your initial purchase.
2. *Parts Included in Basic Price.* Find out exactly what is included in the basic price. The three standard pieces of equipment included are (a) the CPU with basic typing keyboard as part of the basic unit; (b) the display monitor (video or TV); and (c) an input device (e.g., disk drive, tape recorder, cartridge). Sometimes all three come as one unit and sometimes they are separate units. The three pieces as separate units may be easier to have serviced. With some microcomputers, the display monitor can be a home television set with a relatively inexpensive adapter added to it. Other electronic equipment supplied could include joysticks or paddle controllers and a time clock.

FIGURE 3.
Hardware evaluation chart.

HARDWARE EVALUATION CHART			
NAME	**EXTRA DISK**		
APPLE II	Available Extra $ Needed for collecting & storing of IEP data		
ATARI			

3. *Warranty*. Most microcomputers are under warranty for 90 days but require the owner to bring the equipment back to the store for repairs. Check on both the time component and the services and parts included. Also, determine the availability of a service contract and the terms of that contract.

4. *Service/Repair*. Check to see if service is available and how far you must travel for this service. In some instances service is provided in the local or nearby area and in other instances the microcomputer must be shipped back to the factory. Also, find out if microcomputers are available to you for loan while yours is being repaired.

5. *Financing*. Check on financing terms and possible discounts on hardware (including the basic machine) and software. Depending upon your situation, leasing may or may not be the most cost-effective option.

6. *Newsletter*. For many microcomputers, there are newsletters that keep customers updated on programming techniques, available peripherals, and software. These newsletters may also print actual programs from which you can create your own software.

7. *Keyboard*. Note the number of keys, their location, and the type of keyboard. The number of keys may vary from 40 to 79. The location of the keys is usually similar to a regular typewriter keyboard. Some microcomputers also have a separate constellation of numeric keys. Special keyboards, that include such things as "yes"/"no" keys, are available on some computers. Another consideration is the surface of the keyboard. Most surfaces have separate keys, as on a typewriter, while a few have a flat electronic touch-type keyboard. Some microcomputers can only produce uppercase letters,

whereas others can produce both lower- and uppercase letters. In some instances, a software program can be purchased to add this capability.

8. *Added Electronic Parts Available.* It is extremely important, especially in many special education situations, to determine whether your computer can accommodate the peripherals you need and how many peripherals can be used with it at one time. A bus is the part of the computer that provides a path or circuits through which data, commands, or addresses may be transferred to peripheral devices. If your computer does not have extra slots in its bus, you may need to purchase an expansion bus to allow you to attach additional peripherals. Peripherals, or add-ons, could be included in this column or could each be a separate column heading, depending on their importance to your situation. Peripherals can include: speech synthesizer, speech input, clock/calendar, graphics input table, handwritten character input, light pen, printer, music composer, sound effects, MODEM, peripheral adapter, and joysticks/paddles. All of these peripherals will be discussed later in this chapter. At this point note the importance of peripherals in special education and the fact that many are hardware dependent. When evaluating peripherals for specific microcomputers, you should determine which ones are hardware dependent.

9. *Printer.* The printer is one of the peripherals that should be analyzed separately because of its importance. Check to see if there is a printer available that will connect with your computer and that will meet your needs.

10. *Microcomputer Capabilities.* Information such as the following should be included in this category.
    a. Is the display monitor in color or in black and white?
    b. How many picture cells are available for programming graphics? The screen consists of many picture cells, often referred to as "pixels," of which a certain number are designed for programming graphics. "In general, the more picture cells available for programming the clearer the image on the screen" (Wood & Wooley, 1980, p. 89).
    c. How many characters per line and lines per frame are available? Many microcomputers have from 32 to 64 characters per line. This includes letters, punctuation marks, and spaces. For example, "HELLO, MY NAME IS JOE." totals 22 characters. When determining lines per frame, e.g., the number of lines that can appear on the screen at one time, it is suggested that you divide the total lines by two. Print should appear on every other line for

ease of reading. In determining the number of characters per line and lines per page, consider readability. Five lines of print with about 25 words per page has been found to be most effective for many slow learners. Again, the end user should be a deciding factor.

d. What is the memory capability? While 16K may be adequate for very elementary programs, 48K is the minimum needed to run the more advanced high level programs. Also, check on memory expansion capabilities.

11. *Systems Software.* Systems software are the programs needed to make computers function. In some instances, the systems software are actually authoring systems or programs that allow the novice programmer to create software using the English language.

12. *Documentation.* This category is designed for the decision maker to determine if operation manuals are available and comprehensible. Manuals should be available on both systems and applications software—systems software being instructional programs in the teaching of computer languages and applications software being programs designed to meet the other needs of the consumer. Many companies provide their customers with not only instructional manuals but also actual training in the use of the microcomputer.

13. *The System.* Determine if the system is self-contained or has its own CPU and storage system or if it can be integrated into a networked microcomputer system where the microcomputer does its own processing but shares a central data storage system. Networking is less expensive than independent systems but lacks portability and flexibility. The Corvus System is an example of networking and has been effective in larger school systems.

14. *Other.* This column could be used for additional information such as availability of free inservice training, at the time of purchase and as new developments occur. It might also include information on acquiring the microcomputer on a trial basis.

These 14 hardware considerations are not intended to be a set list but examples of how to break down the evaluation of hardware. Categories should reflect the perceived/assessed needs of the school system/university. To find information to complete your chart, read every computer magazine available to you; attend workshops and other inservice programs; invite companies to send representatives to your workshops; attend commercial shows and educational conferences; develop and expand your communication through user groups and through school system consortiums; support local dealers; and get on catalog lists (Smith, 1982).

For Discussion

1. *Why is it important to investigate the options available regarding specific microcomputers before you buy them? Why should you also consider future adaptability of these microcomputers?*
2. *List the options available on the microcomputers that are of interest to you and discuss your reasons.*
3. *List sources in your geographic vicinity that can provide information about microcomputers (e.g., stores, groups, computer users).*
4. *Compare and contrast two or more operating manuals as to readability, comprehensiveness, simplicity, etc., for educators who lack extensive computer knowledge.*

PERIPHERALS

A peripheral is any device that can be added on to the basic computer or CPU. A peripheral may be an input device (such as a disk drive), or an output device (such as a television set or video monitor).

Peripherals are of utmost importance for consideration and evaluation in special education. Many handicapped students served by special education could not effectively use—or in some situations should not use—a microcomputer without appropriate adaptive devices.

Joysticks/Paddles

The two most common peripherals are joysticks and game paddles. These devices allow the viewer to respond to the stimuli on the screen without typing in a response on the keyboard. Instead, the student or viewer can select the right response by simply moving a joystick or game paddle until the cursor (a flashing symbol on the screen) is on top of the preferred response and then pushing a button to register that response.

Light Pen

A light pen is another peripheral that allows the student to respond without typing. The light pen is touched to a particular spot on the screen and the response is recorded. An alternative to a light pen could be a headgear pointer in which responses are made by touching the keyboard or a board that is specially designed for a particular individual.

Sound Effects

Several forms of sound may be added. In some instances, sound may even be part of the original package. It may be in the form of sound effects, musical tones, or voice. For example, the music composer is an addition that permits the user to program music based on numeric responses. A tape recorder can be controlled by some computers to produce appropriate voice recording. Speech is an important peripheral capability, especially for language disabled individuals. A speech synthesizer changes electronic impulses into understandable speech and allows persons who have never been able to communicate using speech to do so. The speech synthesizer is an output device, but there is also a peripheral that uses speech input to allow the user to respond to the computer or to give it commands by voice. This add-on turns speech into electrical impulses, which can be interpreted by the computer.

MODEM

The MODEM, which is an acronym for "MOdulator—DEModulator," is a device that can be added to a computer to permit communication over telephone lines or other communication channels. Information typed into the microcomputer is changed into musical tones by the transmitting MODEM. The MODEM at the receiving end then changes the tones back into a digital form for input into a different microcomputer—thus allowing two computers and their operators to communicate.

Clock/Calendar

A clock/calendar is part of the original package on some microcomputers and is available as a peripheral on others. This device may be useful in operating light switches, timing tests, etc.

Graphics Input Tablet

The graphics input tablet is a peripheral that allows the programmer to create graphics and the user or viewer to input responses by moving a pen over a graphics board. In some instances, a handwritten character input peripheral is available that permits the viewer/programmer to input handwritten information.

Printer

A printer is a very important peripheral to consider if a hard copy (paper copy) is desired. For example, results of assessment in hard copy form are often needed. It is important to evaluate the types of printers that are compatible with the microcomputer you are considering. The dot matrix printer is fast and relatively inexpensive. However, the output is in dot type and is not the easiest output to read. The daisy-wheel printer is slower at printing and more expensive than the dot matrix printer. The print is clear and the type is available in many styles (Bell, 1981). The MX-80 printer, produced by Epson America, Inc., is extremely popular and inexpensive but the basic price does not include the connecting cable or interface board. This type of printer is a dot matrix type and its documentation is easy to understand (Schilling, 1981).

As indicated by these examples, it is suggested that clarity of print, speed of execution, price, plus the capabilities of the printer (ability to execute graphics, etc.) be evaluated and compared to the consumer's assessed needs. A "Buyers Guide: Printers and Printer/Plotters" is a chart that lists the names and addresses of companies that produce printers along with the characteristics of each printer. (See Sources of Further Information at the end of the chapter.)

Peripheral Adapter

One additional add-on that should be considered is a peripheral adapter. This attachment allows the user to expand or multiply the number of peripherals that can be used at one time by a particular microcomputer.

Peripherals are of utmost importance to the special educator since they offer countless possibilities in meeting the individual needs of learners—especially of those who have previously had difficulty communicating.

For Discussion

1. *List the handicapping exceptionalities and their primary needs. Then discuss how the microcomputer could help to meet those needs through the use of peripherals.*

2. *Discuss the peripherals your school or school district would find most helpful in managing special education programs and individualizing instruction for the communicative and educational needs of handicapped persons.*

SPECIFIC MICROCOMPUTERS

One microcomputer that special educators have found to be effective in meeting their needs is the Apple II. A variety of software and peripherals are available for this micro. Peripherals include a graphics input tablet, voice recognizer or voice input peripheral, speech synthesizer, clock/calendar card, light pen, joysticks, and paddles. (Many of the programs discussed in Chapter 5 have been programmed on or for the Apple II and make excellent use of several peripherals.)

The Apple II also has sound capabilities, the availability of a printer, a 52-key typewriter style keyboard, and a disk drive. It can be increased to a maximum of 64K directly addressable memory. Lowercase letter adapters are available, although the basic package is in uppercase only. The display can be either in color or in black and white. It has 40 characters per line and 24 lines per screen (Wood & Wooley, 1980). The documentation is easy to follow, and authoring systems, such as Apple-PILOT and GENIS, are available. The Apple II is available from both Apple Computer, Inc., and the Bell and Howell Company.

The TRS-80, Model III, and the Atari 800 both have expansion capabilities, have educational software available, and are competitive with the Apple II in the educational market. The Texas Instruments 99/4A is another machine that has considerable software available. "Unlike most of the other microcomputer manufacturers, Texas Instruments (TI) has deliberately decided to address only the home and educational markets" (Frenzel, 1981, p. 45). The TI model offers a "unique voice synthesizer [that] . . . allows the computer to generate high quality speech output" (Frenzel, 1981, p. 45). The VIC 20, marketed by Commodore, is very inexpensive but has many drawbacks, including limited memory and a minimum of educationally effective software programs.

Other microcomputers, such as Xerox, North Star, IBM, and Heath/Zenith, are also available but at present they offer little software for the education market.

Since the capabilities of the various machines and the software for each are continually changing, the reader should try to stay abreast of new developments. Articles such as "A Consumer Report on Microcomputer Hardware" (1982) can be used to update knowledge. The companies on top today may not be the companies on top in the future—especially since microcomputer and microcomputer related development are in their infancy.

For Discussion

1. *Select one of the microcomputers discussed and evaluate its applicability to your needs. Determine what other information you need before a selection can be made.*
2. *Consider other microcomputers with which you may have some familiarity. Discuss options as to their effectiveness with various handicapped populations.*

INSERVICE EDUCATION/TRAINING

The third major area of evaluation is inservice training. Most purchasers of microcomputers for educational purposes are professionals in their own fields but lack expertise in computer technology. Information on and experience with the microcomputer is crucial for this tool to become as educationally effective as possible. While inservice training has been limited in the past, it is now available through commercial companies, educational organizations, colleges/universities, and private firms or individuals. This training provides the knowledge and experience necessary to begin to effectively use the microcomputer. Computer technology requires years of education to become highly proficient in its use. In addition, this field is developing rapidly and continuing education is necessary if one is to remain current in the field. However, if a well-developed base of information/experience is provided to the educator, he or she can develop more proficiency as the technology develops.

To develop a base of information, the educator needs some background in the history of the development of the microcomputer. This knowledge will help in understanding the state-of-the-art—its shortcomings as well as its strengths. This awareness also provides some of the insight helpful in purchasing and using the microcomputer. Information on both hardware and software is also necessary to determine which microcomputer to purchase. Information on the uses of the microcomputer in education, and more specifically in special education, will help the educator with evaluating microcomputers and developing creative uses for them. The last area of information/experience includes actually programming software using a programming language and/or authoring system.

The more extensive the training, the more computer literate the educator will become. The more computer literate the educator becomes, the greater the potential for cost-effective and educationally effective uses in the educational setting.

Classes Sponsored By Vendors

Hardware companies, such as the Tandy Corporation (makers of Radio Shack's TRS-80 models), frequently sponsor programming classes at local stores. These classes are designed to teach consumers how to operate their microcomputers using software developed for the specific machine. Classes also provide elementary instruction in BASIC. Other computer stores provide instruction on how to run the equipment they sell. Some will instruct new owners on the care and operation of their new purchase upon delivery.

Some software companies, such as Random House, Inc., sponsor workshops in computer literacy and provide an introduction into their educational software product line. Other companies, such as MCE Inc., provide sessions on computer literacy emphasizing software evaluation.

Education Associations

Education associations prepare special issues of their professional journals and organize workshops at their conventions to inform educators on the state-of-the-art of microcomputers in education. They also provide practical experiences designed to upgrade skills and knowledge. The Council for Exceptional Children, as well as other professional education organizations, have channeled their efforts in the direction of computer literacy. It would be helpful if the local and state education agencies could also provide training through workshops, etc.

Colleges and Universities

Colleges and universities are beginning to instruct their education majors in the use of the microcomputer in the classroom. However, many of the efforts have come from the mathematics and computer departments, where the general knowledge base may or may not include educational principles—especially as they relate to the handicapped population.

Consulting Firms

Private consulting firms, such as Microcomputer Training and Development Associates (MTDA), also offer training. MTDA offers services such as consultation on analyzing needs that may be met through the microcomputer and external evaluation on meeting the assessed needs.

For Discussion

1. *Where in your community could you obtain training and/or inservice education on microcomputers?*
2. *What sources outside of your community could provide this service to you and members of your staff?*
3. *List areas that should be covered in an inservice presentation/workshop within your school/university.*

SUMMARY

Chapters 2 and 3 have presented information to assist the reader in developing a process by which decisions can be formulated as to which microcomputer best meets the needs of the purchaser. The areas of software and hardware evaluation and possible education/training in the use of the microcomputer from both an operational and programming viewpoint were discussed. It was suggested that the reader develop a chart or matrix as a method to organize information for both hardware and software evaluation.

Activities and Further Discussion

1. *Create a hardware evaluation chart that will meet your needs. Be sure to include a key to indicate the questions addressed.*
2. *Create an inservice evaluation form establishing the goals, the performance objectives, and the questions to be addressed to determine if the objectives have been met.*

SOURCES OF FURTHER INFORMATION

Information Sources

"Buyers guide: Printers and printer/plotters," Computer Products, Gordon Publications, 20 Community Place, CN 1952, Morristown NJ 07960-9947

ETC (Educational Technology and Communications), Department of the Far West Laboratory, 1855 Folsom St., San Francisco CA 94103

Fisher, G. Many educators are finding disk sharing both convenient and cost efficient. Here's what to look for when you're thinking about a disk-sharing system for your classroom. *Electronic Learning*, 1982, *1*(5), 47–51. (Evaluation of available disk sharing systems)

King, M. Computer specification chart. *School Product News*, 1982, *21*(6), 24–26.

Minnesota Educational Computing Consortium (MECC) 2520 Broadway Dr., St. Paul MN 55133

Special issue on microcomputers: Their selection and application in education. *AEDS Journal*, 1981, *13*(1).

Webster's microcomputer guide. Hayden Book Company. (Reference book on theory, application, vendors, printers, etc.)

Training Sources

Andersen, Willis W., CAI Research Specialist, Brevard Community College, 1519 Clearlake Rd., Cocoa FL 32922

The Council for Exceptional Children (CEC), Department of Field Services, 1920 Association Drive, Reston VA 22091

Microcomputer Training and Development Associates (MTDA) PO Box 324, Richland MI 49083 or c/o Alonzo Hannaford, Ed.D., Western Michigan University, Special Education Department, Sangren Hall, Kalamazoo MI 49001

Shostak, Robert, Department of Education, Florida International University, Tamiami Campus, Miami FL 33199

Holt, Dennis, Director, Teacher Education Center, University of North Florida, Jacksonville FL 32216

Microcomputer Manufacturers

Apple Computer, Inc., 10260 Bandley Dr., Cupertino CA 95014, Phone: 408-996-1010

Atari, 1265 Borregas Ave., Dept. C, Sunnyvale CA 94086, Phone: 408-745-2000

Commodore Pet, 681 Moore Rd., King of Prussia PA 19406, Phone: 215-666-7950

Compucolor, PO Box 569, Norcross GA 30091

Heath/Zenith Company, Hilltop Rd., St. Joseph MI 49085, Phone: 616-982-3200

Hewlett-Packard Company, 3000 Hanover St., Palo Alto CA 93404, Phone: 415-857-1501

IBM, 33 N. Dearborn, Chicago IL 60602, Phone: 312-245-2000

North Star, 1440—4th St., Berkeley CA 94710

Osborne, 26500 Corporate Ave., Hayward CA 94545, Phone: 415-887-8080

Radio Shack, TRS-80, 1300 One Tandy Center, Fort Worth TX 76192
or Tandy Corporation, 2617 W. 7th, Ft. Worth TX 76107, Phone: 817-390-3700
Texas Instruments, 12501 North Central Expressway, Dallas TX 75222, Phone: 713-895-3538
Xerox, 5310 Beethoven St., Los Angeles CA 90066, Phone: 213-304-4000

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Bell, A. Computer anxiety. *Media and Methods*. 1981, *18* (3), 4–5; 25.

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Carpenter, C. Z-80 softcard from microsoft. *Creative Computing*, 1981, *7* (9), 144–146.

A computer report on microcomputer hardware. *Curriculum Review*, 1982, *21* (2), 155.

DeMartino, M. Selecting your computer and your computer dealer. *Personal Computing*, 1981, *6* (1), 109–110.

Frenzel, L. Learning with micros. *Interface Age*, 1981, *6* (12), 44–45.

Hauso, J. *Management application of the microcomputer: Promises and pitfalls*. Paper presented at the Annual Conference of the Association for Educational Data Systems, Minneapolis, May, 1981. (ERIC Document Reproduction Services No. ED 201 410).

Kubeck, B. So you want more memory. *Creative Computing*, 1981, *7* (9), 84–85.

Lubar, D. So you want to buy a music synthesizer. *Creative Computing*, 1981 *7* (9), 86; 88.

Mathes, S. Using microcomputer graphics to train teachers. *Creative Computing*, 1982, *8* (4), 88.

Perry, T., & Zawolkow, G. CAI: Choosing hardware and software. *Apple Orchard*, 1982, *3* (1), 22–24.

Schilling, L. Hard choice for hard copy. *Media and Methods*, 1981, *18* (2), 15.

Smith, M. Letters to the editor. *Computing Teacher*, 1982, *9* (6), 4–5.

Stevens, D. Computers, curriculum, and careful planning. *Educational Technology*, 1981, *21* (11), 21–24.

Wood, R., & Wooley, R. So you want to buy a computer? *Instructor*, 1980, *39* (7), 86–90.

CHAPTER 4

Media Selection and Microcomputer Uses

As You Read This Chapter, Think About:

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1. *The future of special education as a result of the microcomputer.*
2. *A process by which a specific medium can be evaluated to determine if it is the best available for teaching a specific concept/skill.*
3. *Uses of the microcomputer for the teacher (instruction-related) and for the administrator (data management, etc.).*

INTRODUCTION

The microcomputer, if used appropriately, will prove to be the breakthrough in education that will provide total individualization for all learners. They will be able to move through a competency-based curriculum at their own speeds, using approaches and task-analyzed materials designed to meet their specific and assessed needs. These statements in no way mean that the teacher will be replaced by a machine. It does mean that teachers will have the time to plan for and monitor the progress of each student. It does mean that the teacher will be free to facilitate and organize educational programs and materials for students. It does mean that the teacher and administrator will have an invaluable aid to do data collection, analysis, and retrieval. It does *not* mean that the classroom teacher will stop relating to students. It does mean that the educational profession will have to change the way education is implemented. But the responsibility of delivering effective education *does not* and *will not* belong to a machine—except as it has been programmed. The responsibility for education will belong, as it does now, to the educator. Therefore, educators must understand the possible classroom uses for the microcomputer and be able to analyze program goals and needs. This is necessary before they can make judgments as to the best and most cost-effective educational methods/materials available to meet their goals and objectives. The role of the educator may eventually change, but the primary goal of education will not.

The microcomputer should be considered an aid to the educator and an aid in the educational process. According to Hannaford and Sloane (1981), the microcomputer, when properly programmed, can:

> Provide a multisensory approach to learning.
> Be used to teach a wide range of subject matter.
> Be used with diverse student populations.
> Provide direct, individualized, interactive instruction.
> Allow a student to learn at his or her own rate.
> "Remember" student responses.
> Provide instant feedback.
> Give a variety of reinforcements.
> Provide repetition, drill, and practice in a meaningful manner.
> Provide diagnostic and prescriptive information to the teacher.
> Be used as an ideal management and retrieval system for student records, assessment scores, student objectives, and IEPs.
> Free the teacher from hours of repetitious paper and pencil activities. . . .
> Provide continuous encouragement to a student and facilitate active participation in the learning process. (p. 54)

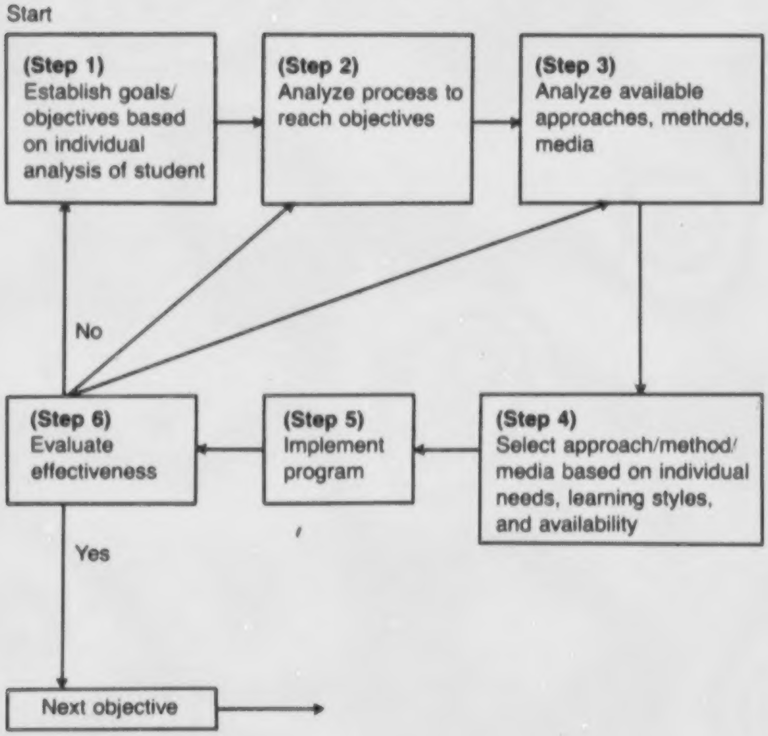
The phrase, *if used properly,* cannot be emphasized too strongly. Software evaluation was discussed in Chapter 2, and as indicated there is little educational software on the market and much of what is available is not educationally effective. Furthermore, even if software passes the evaluation test, this does not mean it should be used in all educational situations. This brings into view one further area for evaluation. Even if the software is programmed following the educational principles and making the most effective uses of the technology, it may not be the "best" medium or method to use to meet a particular goal or need. It is also possible that what is the most educationally effective for one student may not be for another. For example, a program with much visual stimulation and no auditory peripheral would not help a student who is primarily an auditory learner and has severe visual problems or visual perception problems. In fact, it could have a negative effect.

MEDIA SELECTION

The model shown in Figure 4 could be employed to determine which medium to use or if a particular tool, such as the microcomputer, would be the best to use in reaching educational goals.

The first step in selecting any medium should be to determine the goals and then to determine the educational objectives in specific terms to progress toward those goals. The second step is to determine exactly what process is needed to reach each stated objective. This process involves analyzing the audience, which may be one learner or a group of learners. The third step is to analyze available medium and programs. At this point the educator needs to look at not only the microcomputer

FIGURE 4.
Media selection diagram.


Start
(Step 1)
Establish goals/objectives based on individual analysis of student
(Step 2)
Analyze process to reach objectives
(Step 3)
Analyze available approaches, methods, media
No
(Step 6)
Evaluate effectiveness
(Step 5)
Implement program
(Step 4)
Select approach/method/media based on individual needs, learning styles, and availability
Yes
Next objective

and the available software but also the alternative medium and methods available, such as filmstrip, tape recorder, movie, field trip, lecture, discussion, and outside resources. Then (step 4) the decision can be made as to which medium, if any, will be both educational and cost-effective in meeting the objective. After implementing a method of presentation (step 5), for example the microcomputer, evaluation should continue on a formative basis (step 6). If, for example, the microcomputer or the microcomputer program is not being effective, a number of avenues need to be investigated, including looking at the objectives and making an appropriate change, reanalyzing the process as it relates to the audience, and possibly selecting an alternative method, medium, or approach.

Following a process such as the one described here, summative evaluation should take place. This is especially important in the development of the microcomputer in education because long-range research is limited and much of the software has had limited educational input. This process was described as it relates to selecting medium for educational purposes. However, a similar process should be employed for selecting administrative and data collection/analysis methods, whereby the determination is based on cost-effectiveness, ease and speed of inputting and retrieving information, and assurance against "loss of memory."

The remainder of this chapter is divided into three sections surrounding the educational profession's uses of the microcomputer—instructional uses, instruction-related uses, and administrative uses.

For Discussion

1. *Defend the statement, "Microcomputers will not replace the teacher."*
2. *What changes in education do you foresee as a result of microcomputers being used in the classroom for the next five years? Twenty years?*
3. *Describe one student with whom you have contact who might benefit from interacting with a microcomputer program and one with whom it might not be beneficial. Defend both.*
4. *What are methods you might employ to evaluate the effectiveness of specific medium, materials, and approaches?*

INSTRUCTIONAL USES

Although long-term research results are limited as to the educational effectiveness of the microcomputer, Gleason (1981) indicated a number of conclusions based on research conducted to date:

1. The microcomputer assists learners in reaching instructional objectives.
2. A 20% to 40% savings in time spent learning is realized through computer programs as compared to "conventional" instruction.
3. Retention after interacting with programs is as good as or superior to "conventional" instruction.
4. Students tend to respond positively to good computer assisted instruction (CAI) but negatively to poor programs.

Research by Joiner, Sedlak, Silverstein, and Vensel (1980) concluded that microcomputers have been more educationally effective with lower ability students than with higher ability students. Luttner noted that "functional as a given computer and apparatus may be, if it is not fun for the user, it will not be used" (1981, p. 29). These reports are just a few of those indicating the possibilities for positive effects in the classroom if effective software is used—and used correctly.

The microcomputer has many direct instructional uses. In general, the computer can:

> 1. Impart information on a one-to-one basis with a high success rate when well-written and thoroughly validated programs are used.
> 2. Provide imbedded remedial instruction of which the student may not necessarily be aware.
> 3. Provide enrichment material within the program.
> 4. Keep accurate track of progress throughout the program, and, indeed, throughout a series of programs on varied material.
> 5. Allow the student to progress at his own rate (perhaps the most important use).
> 6. Provide video and audio support via peripheral devices linked directly to the computer.
> 7. Provide a massive information retrieval base—either by directly displaying the material itself or by directing the student to the appropriate medium. (Herriott, 1982, p. 82)

Instructional uses of the microcomputer fall into one of six categories (see Figure 5).

FIGURE 5.
Classifications of instructional microcomputer programs.

CLASSIFICATION	DESCRIPTION
Computer Managed Drill & Practice (CMDP)	To reinforce information learned and to provide practice.
Computer Managed Tutorial (CMT)	To present information already presented in the classroom but which has to be retaught (broken into smaller steps and/or presented at a lower conceptual/reading level).
Computer Managed Concept Instruction (CMCI)	To instruct the learner in subjects through individualized sequencing, using the branching capabilities of the microcomputer.
Computer Managed Simulation (CMS)	To place the learner in situations that replicate original situations.
Computer Managed Problem Solving (CMPS)	To place the learner in situations to solve problems and to receive appropriate consequences.
User Managed Problem Solving (UMPS)	To develop and program software using methods appropriate to individual technical knowledge and ability.

Computer Managed Drill and Practice

Many of the programs found on the market today fall into the category of computer managed drill and practice (CMDP). The learner is presented with a problem, he responds, and if correct goes on to the next problem; if incorrect he goes back through the same problem again. Some reward is usually given for correct responses. For incorrect responses, a neutral message saying to try again, positive praise for trying, or a punishment like "DUMMY" is given. Although this latter example does not follow good teaching principles, programs with this type of punishment are found on the market. Drill and practice is an important part of the teaching program and can be applied to math and spelling as well as to some aspects of history, geography, or vocational education. This type of program could be especially beneficial to the student with memory problems. Not only is the information seen and perhaps heard but a motoric modality is also used when the learner types or otherwise indicates an answer. The microcomputer is also "patient" and does not show displeasure with the student who takes excessive time to memorize.

Computer Managed Tutorial

Computer managed tutorial (CMT) is another category of interest to the special educator because programs of this type assist in the mainstreaming process within both the regular and the special education classrooms. Coursework, previously presented but not understood or remembered, can be retaught. The program can teach a concept and then assess the student's understanding of that concept. Based on the results of assessment, the next concept will be presented or the same concept will be retaught at a more appropriate level, where the concept is broken down into smaller steps and/or approached differently.

Computer Managed Concept Instruction

Computer managed concept instruction (CMCI) is similar to CMT in the way it is presented, but it is designed to aid in the original instruction of concepts or subjects. With this type of program, the learner who is having problems will be branched or directed to a lower level whereas the student who has already mastered the information can be branched to a higher level. As branching occurs, not only is the material arranged in smaller or larger steps but the reading or conceptual level is adjusted accordingly. For example, if the material is originally presented at a third/fourth grade reading level and the learner has difficulty, the student is not only branched to a lower level where the concept is broken into smaller steps but the steps are more concrete and the reading level is lower. Conversely, if the learner is totally successful at a particular level and the presentation is too simple, the opposite occurs. Whenever possible, and especially on the higher levels, both convergent and divergent thinking are built into the problem solving and simulation activities—which brings us to the next category.

Computer Managed Simulation

Computer managed simulation (CMS) is "a quantitative model or description of complex events, either real or created ... [where] learners have the opportunity to access complex variables and measure the results of their own intervention in a problem situation" (Steffin, 1981, p. 13). These "simulations provide the learner with the opportunity to try out, without negative reinforcement, widely divergent approaches to problem-solving" (p. 12). There are a number of reasons for substituting simulations for the real life situation. Among these reasons are:

1. To make up for unavailable equipment.
2. To act as a substitute for experience.
3. To provide rapid and realistic results in which the time scale would normally be too difficult.
4. To eliminate situations of danger. (Doctorow, 1981, p. 16)

Some simulations involve searching for an item, having been given a number of clues. Other simulations involve resource management, where the viewer is given a number of resources, rules, and a goal to achieve (Spivak & Varden, 1980). For example, in a game called "The Prisoner" the learner is placed in "a psychological prison camp, where the adversary's sole objective is to ferret out information from the player. The player, on the other hand, has only one goal—he (or she) thinks—to escape from his (her) captors" (Steffin, 1981, p. 13). (The Prisoner is available from Edu-Ware Services, Inc., 22222 Sherman Way, Suite 102, Canoga Park CA 91303.) Other simulations could involve the learner in fighting historic battles, docking spaceships, analyzing the development of a human being through a time-lapse situation, and driving cars through city streets. Airplane pilots receive recurrent training in simulation trainers which resemble the front portion of an airplane, with a moveable base. Similar simulations would provide an excellent way for special education students, as well as many others, to learn to drive.

Computer Managed Problem Solving

Computer managed problem solving (CMPS) involves programs which are structured to stimulate the student to solve problems. These programs allow the student to input relatively unstructured information in order to investigate particular concepts. Science, Social Studies, and English are three curriculum areas that lend themselves to this type of program. For example, the learner could analyze and compare various materials, including literary works. Creative writing could also be programmed using software called text editors or word processors. The learner could write and edit or change both the content and the format and then produce the final results using the printer.

User Managed Problem Solving

All the programs or categories of programs discussed thus far are in the tutor mode or are programs that have been developed with specific student purposes or goals in mind. Another way of using the microcomputer that involves the general category of problem solving places the student in the tutee or programmer mode. This category of instructional microcomputer programs is called user managed problem solving (UMPS). To solve problems associated with programming, the mind must think logically. If one begins to think logically in one situation, such as programming the microcomputer, the logic may be transferred to other situations. The level of programming, of course, depends on the student's knowledge of programming as well as his or her ability to think logically. While one student with limited ability could use LOGO, an authoring system originally designed for children, another could use BASIC. The very advanced student could handle machine language. UMPS would be an excellent area for research—especially research involving special education students and their development of problem solving techniques. Programming has already helped some teachers and prospective teachers with task analysis of concepts and skills to be taught to students.

Teacher Uses

The microcomputer has a variety of educational uses for the teacher. Imagine a system that allows for central storage of many programs either within the individual classroom or at an outside location, permitting the teacher or student to call up a program and view it at the desired rate of speed and desired level of presentation. This allows many students to be able to view the same program, or concepts, at the same time, with each one receiving the presentation designed to meet his or her individual needs as to reading or conceptual level and speed. The system could even individualize the appropriate concept within a program based on pretesting. In other words, each learner would only be presented the concepts for which mastery is lacking. This type of system would require something similar to that developed by Corvus Systems. Corvus Systems use hard disk storage and a network system with a minimum of 5 megabyte memory to an expansion capacity of 80 megabytes and a 64 computer network. (To give the reader some idea of the memory capacity involved here, a 10 megabyte system stores up to 67 diskettes.) The Corvus Systems are compatible with many microcomputers.

The microcomputer not only assists the teacher but also provides a positive atmosphere for the student since it can patiently present information repeatedly or in different ways without showing frustration to the learner who is having difficulty. As one student said, "It's okay to make a mistake. The computer doesn't always yell at me" (Taber, 1981, p. 4). The teacher, incidentally, did not "yell" at this student. The student felt frustrated and projected her own frustrations onto the teacher. The microcomputer is a machine. The emotion perceived by human interaction does not exist.

The ideas presented here only scratch the surface of possibilities, and the depth of ideas for programs is only limited by the creativity of the educator and programmer of the software. One word of caution here: Software cannot do all the teaching. Instructional guides and, of course, the teacher need to provide the materials to make sure that the learner has the prerequisite skills to successfully complete the program. Ancillary materials and activities are also frequently needed to augment the learning situation. The microcomputer is only a tool, and as a tool, it is only as effective as it is programmed to be.

For Discussion

1. *Evaluate and describe software that falls into each of the five instructional categories.*
2. *Discuss the differences and similarities of tutor and tutee mode programs.*
3. *Describe how you could use a word processing program to teach written communication skills to a student who has a specific handicap.*

INSTRUCTION-RELATED USES

A number of duties are assigned to the classroom teacher beside giving direct instruction to students. These duties include (a) collecting information, (b) storing information, (c) organizing information, (d) developing reports, and (e) developing materials and approaches. All of these duties must be carried out for the teacher to teach effectively and to demonstrate accountability. Therefore, instruction-related purposes cover the areas to which the teacher must attend that are related to the educational process but not directly connected with instruction. They assist the teacher in managing administrative responsibilities. The following list of instruction-related uses is not meant to be all-inclusive but is designed to stimulate the imagination of the reader in creating additional possibilities:

1. Assessment and error analysis to provide information for writing individualized education programs (IEP's).
2. Data collection and retrieval to provide progress information on both the learner and the teacher.
3. Data collection and retrieval to monitor the reaching of objectives and the methods and materials that do or do not work.
4. Grading information, averaging, etc., in order to have instant and constant retrieval of information for each student in the class. For example, a teacher in Michigan is using this technique for motivational purposes where each student gets a weekly computer printout of his or her average in the class.
5. Equipment and materials inventory both for what the teacher already has in the classroom as well as what he or she would like to order when monies are available or for the yearly budget. This latter program could provide the teacher with an instant printout of each item desired, the cost of each item as well as a running total, the address of producers, etc. This list could also be rank-ordered with the option of changing the rank order.
6. Student schedules so that teachers could know exactly where all students under their jurisdiction are at a particular moment as well as instant semester scheduling of students.
7. Pretests and posttests on students to determine progress after interacting with software or after a lesson has been presented using another medium or teaching technique.
8. Reports to parents and administrators, including research generation, analysis, and reporting; letters to parents and others; class notes on presentations; and anecdotal records.

To summarize, the microcomputer assists the teacher as it: (a) individualizes instruction within the classroom; (b) provides a nonthreatening presentation to the learner; (c) teaches process and product through sequential steps; (d) extends the teacher's expertise; and (e) provides data collection and retrieval designed to assist the teacher with nonteaching activities.

For Discussion

1. *List instruction and instruction-related needs that you perceive the teacher to have that could be met with a microcomputer.*
2. *What role do you see an aide playing in special education within the next 5 to 10 years?*
3. *How would you positively approach parents to explain an IEP or progress report that was microcomputer generated?*

ADMINISTRATIVE USES

The microcomputer provides the administrator with fast and accurate access to information stored in a minimum amount of space. Again, this list of administrative uses is not intended to be a complete list but one designed to stimulate the imagination of the administrator.

Data collection, organization, storage, and retrieval of:

1. Basic competency and other test records with the capability of instant analysis for diagnostic purposes.
2. Students' permanent records.
3. Individualized education programs (IEP's).
4. Attendance.
5. Scheduling of students in regular and special classes.
6. Data collection and retrieval for report generation, including word processing for editing, proofing for errors, and instant printouts.
7. School calendar and organization of administrative schedules, IEP meetings, etc.
8. Instant progress reports on students for parents.
9. Legal information including changes in the law as they occur.
10. Budget development and instant updates as to the status of the budget.
11. Instant updated school census report.
12. Cataloging of materials within each classroom.
13. Cataloging of professional libraries.

One administrative system designed to operate on the Apple II with 48K using a Corvus hard disk system that would meet many of the above listed needs, either directly, through modification, or by providing a basic design, is the Student Scheduling and Tracking System (SSTS). The system, designed for W. P. Davidson High School in Mobile, Alabama, was jointly developed by the school and computer specialists to develop a system to manage "student data management, scheduling, and grade reporting" (Bolton, 1982, p. 24). As information about students changes, the school simply enters that data and has an instant update on those files.

An additional microcomputer use, not usually considered, involves staff development. Programs could be employed to (a) instruct teachers in the use of new methods; (b) instruct teachers in the use of new media such as the microcomputer and other technological advances as they develop; (c) instruct teachers in classroom organization and discipline; and (d) provide teacher self-evaluation through a nonthreatening medium whereby teachers input information, for example, on how a situation was handled. This type of program could then branch to a section designed to provide the probable consequences of the teacher's action plus alternative methods by which to handle that particular situation.

For Discussion

1. *List needs you perceive the administrator to have that could be met with a microcomputer.*
2. *Describe the data that could be collected and fed into a microcomputer that would assist you in writing specific reports or would meet at least one of your needs.*
3. *How could you use the microcomputer to evaluate the teacher in order to assist him or her with professional growth and development?*

SUMMARY

Chapter 4 has presented microcomputer uses that assist in implementing individualization for all students in the classroom. It has presented uses to help both the teacher and the administrator carry out their organizational and administrative tasks in less time leaving them more time for other responsibilities.

Activities for Further Discussion

1. *Taking one concept or skill, write the educational component of a program breaking down that skill or concept into sequential steps for someone with a specific reading level. Print exactly what is to be seen on the screen at one time and number the sets of information (the frames) consecutively as you write them.*
2. *Taking the same concept or skill, rewrite the component at a lower reading/conceptual level, breaking the concept or skill into appropriate steps.*
3. *Add to the list of needs you started earlier the needs you determine to be applicable to your situation that could be met through the use of a microcomputer.*

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CHAPTER 5

Microcomputer Uses In Special Education

As You Read This Chapter, Think About:

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1. *How to best use the microcomputer for the major special education categories.*
2. *How existing computer equipment or planned equipment for your school district could be modified to meet the individual needs of students within your jurisdiction.*

INTRODUCTION

The microcomputer—what can it do for handicapped learners? The possibilities are limited only by imagination, time and money. The technology exists to do almost anything; the microcomputer age is fast becoming a reality. Probably, the biggest barrier is the unwillingness of educators to change and to keep up with emerging technology. It is essential for educators to receive inservice education and to attend workshops on a regular basis. And it is essential for school administrators and policy makers to be open to change and to the implications these changes can have on the learning environment. "We, in special education, have always been innovative in our approach to teaching special populations. . . . For years, we have used manipulative devices and sensory equipment for students with handicapping conditions" (Hannaford & Sloane, 1981, p. 54). It is time, again, for special education to demonstrate the possible uses of a new technique, a new technology, in meeting the educational needs of all learners—especially those needs that have previously been difficult to meet.

This chapter provides a glimpse of some ways the microcomputer has been used with disabled people. It also provides suggestions as to possible future microcomputer uses that could lessen, or perhaps in some instances eliminate, the disabling effect of a handicapping condition.

For Discussion

Outline a plan to inform and involve teachers, administrators, policy-making board members, and community members in using the microcomputer as a method of individualization and as a change agent in the educational process.

THE MICROCOMPUTER IN SPECIAL EDUCATION

Physically Handicapped Students

The microcomputer has already been used in a number of ways with students who are physically handicapped. Physically handicapped students have used joysticks and headpointers to respond to questions and other stimuli. They have also used other operating controls such as the manual pointer and the rocking lever. Light pens can be used to respond to questions and to give other input into the operation of a program. Light pens can also be used to access programs from disks, create high resolution graphics using a graphics board, and even edit programs (Keeley, 1981).

A number of examples of the use of microcomputers by the physically handicapped have been reported in the literature. One young boy who was paralyzed from the neck down as a result of an injury at the age of three is now, with the help of his brother and a modified Apple computer, doing his own programming (Sand, 1981). (The modifications are thoroughly described in Sand's article.)

A father found a way to use a joystick to enable his child to control cursor movement on a video screen. He went on to improve this process by developing a 10-key keyboard the child could operate by elbow or fist. In this system two key punches add one character to the message—one indicates the row and the other indicates the column. This program is called Geim's Haniterm (Luttner, 1981, p. 28).

A significant improvement in the sense of personal worth was reported for severely physically handicapped adolescents with cerebral palsy after their experiences working with LOGO. The youngsters used LOGO for business programming using mathematics, work on spatial deficits, remedial writing, and diagnostic efforts using graphics and seriation tasks (Papert, 1981).

A young man with cerebral palsy and a severe communication handicap gained access to a keyboard by using a wrist brace and the eraser end of a pencil. This young man's parents run workshops to inform others about their son's use of the microcomputer (Apple Computer, Inc.).

The Alpha Menu program, developed by Bill James in San Antonio, Texas, builds messages at the top of the screen from letters, numbers, and punctuation marks displayed on a matrix. The Alpha Menu program can be operated by a light pen, skate controller, or any other device designed for the specific physical handicap (Luttner, 1981, p. 27).

A voice synthesizer, called a Supertalker, is being used in connection with the Apple computer, allowing handicapped persons to communicate by using a paddle button. The input is then transformed into speech (Rendzio, 1981). Schneider (1981) reported on a speech synthesizer that takes keyboard entries and turns the input into speech through a ROM chip. He also described a word board used by nonverbal students, and a system called Autocom from Telesensory Systems, Inc., that uses a RAM chip. The Autocom contains vocabulary arranged on an adjustable grid. Friedman at the Rehabilitation Institute in Pittsburgh, Pennsylvania, has developed a system "using an AIM-65 microcomputer, a TV camera, and some other hardware [which can] track the eyes of a person unable to speak. As ... [people] look at the words displayed in front of them, the computer will speak to them" (Busch, 1981, p. 73).

Some programs operate on voice command. One such program, which also can operate using a switch or joystick, is the C2E2 (Control Communications, Education, and Entertainment) system from the University of Alabama in Birmingham, Alabama. With the slightest movement, the user can operate appliances that require 110-volt AC power. This program can also operate a telephone and music synthesizer. The C2E2 system operates on the Apple II with two disk II drives, two CRT monitors, a speech interface by Heuristics, Inc., a printer, and a custom piece of hardware called a "simple 'black box,' which connects the Apple system to the user's telephone and appliances" (Luttner, 1981, p. 26).

Other programs for those who are severely limited have been developed to do such things as answer the telephone, write letters, turn down the radio, and operate a number of appliances. These programs have been developed by Artra, Inc., and are called the Artra Housemaster package. They are designed to work on a Heath/Zenith 89 but presently are being expanded to run on other personal computers. The Artra Housemaster allows quadriplegics and other handicapped individuals to control almost everything in the home, from appliances to sensing devices that sense when intruders enter the home and call the police. Sensors can even control such items as lights, turning them on and off at a particular time or at a certain level of darkness (McLamb, 1982). The computer can be controlled in two other ways: through voice control and/or through a remote keyboard. The cost of the Artra Housemaster package is less than $500.

The area of homebound education has likewise been touched by microcomputer technology. A microcomputer at home can be hooked up through a MODEM and telephone to the place where a teacher is located. The student can receive instruction and type in responses on interaction/question frames which can then be corrected immediately with instant feedback (Joiner, Sedlak, Silverstein, & Vensel, 1980). This device can also be used within a hospital setting. A person who is both deaf and blind can communicate with a sighted person located somewhere else by using a MODEM hooked up to a computer. The blind person uses a Braille device hooked to a microcomputer-brailler. This lets the person generate input and receive information in Braille on a reading board with "moveable pins which raise and lower under microprocessor control" (Uslan, 1982, pp. 2–3). The sighted person, with no knowledge of Braille, receives the communication in print on the screen and types in information using a standard keyboard.

Visually Impaired Students

Other developments in microcomputer technology have aided people with visual impairments. A synthetic speech device is available from the International Business Machines Corporation for visually impaired typists. This device can be attached to IBM magnetic media typewriters. The speech sounds and preprogrammed pronunciation rules are stored in electronic memory circuits (Schneider, 1981). Several talking calculators have been developed including the Speech Plus Talking Calculator, which has a 24 word vocabulary. A Talking Telephone Directory has been developed that, when given a name, provides auditory and visual output of telephone numbers, credit limits, etc. One speech synthesizer, called the Total Talk Computer Terminal, has an unlimited vocabulary with adjustable pitch, volume, tone, and speed—from 42 to 720 words per minute (Ashcroft & Young, 1981).

One especially valuable machine being used with the blind and visually impaired is the Kurzweil Reading Machine designed by Ray

Kurzweil, a graduate from M.I.T. This machine "uses an electronic scanner with a speech synthesizer to read printed material aloud. It is programmed for one thousand exceptions and can read 200 different type faces at up to 250 words per minute" (Cushman, 1981, p. 42). The Kurzweil Reading Machine is operated by placing written material on a glass surface. Upon command, activated by pressing control keys on a computer terminal, a camera moves back and forth under the glass and across the page of the written material. The machine has speed and tone control as well as the capability to spell words, give pronunciation, and repeat portions of the material. In addition to this machine, Kurzweil Computer Products, Inc. (33 Cambridge Parkway, Cambridge MA 02142) has created the Kurzweil Talking Terminal "which will enable voice impaired people to communicate orally when it is attached to a terminal and a print-to-Braille machine [and] which will convert a 500-page book to Braille in three days instead of the usual three to six months now required" (Cushman, 1981, p. 145). Unfortunately, this machine is very large and expensive.

Other innovations for the visually impaired include a modification of the game Simon (an auditory/visual memory game). It uses six switches arranged in a Braille dot pattern. It is activated by a handheld magnet and includes a program to teach Braille to partially-sighted children. Large alphabetic characters plus their equivalent Braille patterns are seen on a television screen. Morse Code signals for the letters are also available (Apple Computer, Inc., p. 8).

Hearing Impaired Students

Microcomputers have also been used with hearing impaired individuals. Since the microcomputer presents material primarily through the visual modality, it can often be used with no modifications. One modification, developed by Ted Perry from Carmichael, California,

> allows an Apple personal computer to communicate with the Baudot and ASCII devices. With this system, a person can hook up to computer information networks and still communicate with deaf people who use Baudot teletypewriters. (Apple Computer, Inc., p. 8)

Baudot is a system by which characters are translated into electronic code. The Amateur Research and Development Corporation (AMrad) has developed a system that can be used with an Apple using Baudot teletypewriters whereby a small box "connects the Apple's game socket to a MODEM for the teletypewriter" (Apple Computer, Inc., p. 8).

Currently under development is a machine funded by a grant from the International Year of the Disabled. It is a speech training device that will "enable people with severe loss of hearing to 'see' a visual image of their utterances" (Micro-Scope, 1981, p. 18). Another innovative adaptation that can be used by the deaf is Deafnet. This is a form of electronic mail that uses a computer terminal and a telephone coupling device or MODEM. ("Computers for the Handicapped: Panacea or Pie in the Sky," 1982, pp. 4–5).

In response to a contest sponsored by the Applied Physics Division of Johns Hopkins University and the Tandy Corporation, another system has been developed that can assist the hearing impaired.

> Dr. Ken Macurik developed a computerized vocalization trainer that is individually paced to the hearing impaired student. The program allows vocal sounds to be converted to visual patterns on a television screen. The hearing impaired individual can practice from reading the visual patterns until she/he achieves a similar vocal pattern. (Magliocca, 1982, n. p.)

The cost of this item at the present time is less than $600.

Autistic Students

Information on the effectiveness of the microcomputer is beginning to surface in the area of the treatment of autism. Autistic children seem to be especially fascinated by the microcomputer and comfortable interacting with it.

A field study conducted by MCE Inc. reported much success in using a commercially developed microcomputer program with autistic children. Imitating a machine-like voice, the teacher made an audio tape which she played while the students watched a program. Next, she positioned herself near the tape recorder but spoke, herself, using the same mechanical voice. Finally, she eliminated the machine quality of her voice and communicated with the children in her normal voice. In the teacher's evaluation report, she said:

> They became very excited . . . one boy 'sang' all the directions . . . I was thrilled. It's the first time he took an interest. I didn't even know he could add. (MCE Inc., 1982, p. 15)

Emotionally Disturbed, Learning Disabled, and Mentally Retarded Students

Research involving 18 hyperactive 6- to 14-year-olds used a computer program to test for change in behavior for completing mathematical problems. The software program used in the study was individualized to the child's level of problem difficulty. The display was readable, using extra spacing between characters. The answer format was as close to a paper and pencil format as possible (i.e., inputting from right to left). Problem solving was self-paced. When the child was ready to give an answer, he pushed a button and the program advanced. If answers were right, praise was given; if answers were wrong, the student was told he was wrong and the correct answer was given. "Built-in messages . . . were specifically related to the child's problem of hyperactivity—special messages appeared whenever a child answered too quickly, took too long to respond, or simply made too many inappropriate button presses" (Kleiman, Humphrey, & Lindsay, 1981, p. 93).

Other children needing positive feedback have been reinforced as they viewed programs that were "patient" and individualized to their levels. For those with learning problems, the individualization is especially important because branching to appropriate conceptual and reading levels can occur with presentations that remain at the same interest level. Children with short-term memory problems have been helped because microcomputer presentations can provide prompts and multisensory approaches to learning. Tasks, such as tracing over dotted lines with a light pen, typing in missing letters, and identifying correct words have all been used successfully. For students who respond too quickly, the keyboard can be locked until sufficient time has elapsed for a reasoned response to be given (Grimes, 1981) or messages can be placed in the program, telling the student to slow down.

Seymour Papert's work has indicated that problem solving skills can be developed through computer programming and that learning impaired children can increase their writing ability by using a word processor. Furthermore, carry-over into other academic areas was demonstrated (Moursund, 1981).

Gifted Students

Microcomputers offer the gifted learner an opportunity to be involved in advanced problem solving and highly technical programming—an obvious resource for program development where software is needed within a school system/university. Simulation programs can also provide a challenge to the gifted learner as well as expand the depth of the curriculum and increase the wealth of information that can be presented in the classroom. The microcomputer can help gifted learners in areas that need strengthening—allowing them to work on their own and progress through branched programs designed to stimulate interaction with the concepts presented.

Testing

Using the microcomputer for testing offers a number of advantages. Individuals who have difficulty communicating can use a microcomputer with appropriate peripherals to answer test items through different response modes. By providing new options for communication, information that was previously impossible to collect can now be obtained. Testing by microcomputer may well reduce anxiety felt by some students during situations in which human interaction is involved, thus increasing the validity of the results. Test results can also be objectively analyzed. Error diagnosis, student strengths and weaknesses, data storage, correlation with other test results, generation of achievement curves, and other types of data analysis can also be performed. Programs that analyze test results have been developed by testing companies. For example, South Microsystems for Educators in North Carolina has developed a program that analyzes the Wechsler Intelligence Scale for Children, revised edition (WISC-R), and provides interpretive information about the results. The interpretations and recommendations are both clinical and educational (National Association of State Directors of Special Education, July 9, 1982).

Individualized Education Program

Test analyses in combination with other information generated by questionnaires, observation checklists, interviews, and so forth could be used to individualize every student's educational program. Computer analysis could generate and update individualized education programs (IEP's) for the special educator. All areas of these plans could be stored, from the diagnosis to the methods and materials appropriate to reach the educational objectives. Minutes from meetings could be voice entered and printed so that all involved persons could have instant transcripts. Besides the time and energy saved, there is the added value of the relatively objective diagnosis of learning problems.

This use of microcomputer technology has already been developed by several agencies including the Public-Child-Based Information System of the Central Susquehanna Intermediate Unit, Lewisburg, Pennsylvania; and Gacka Computer-Aided IEPs from Curriculum Associates, Inc., in North Billerica, Massachusetts (Wilson, 1981). Other computerized IEP systems include the Modular Student Management System from Educational Systems in Falls Church, Virginia; and a program called Microplanner from Learning Tools in Brookline, Massachusetts ("Programming IEP's," 1981). The Control Data Corporation has also been working on a system, using PLATO terminals, that "monitors a student from initial screening for the handicap through assessment, program selection, I.E.P. development and educational achievement" (Wilson, 1981, p. 9). An additional program, called Project IEP, found at the Evans Newton Incorporated Software Library prints 15 different reports for the teacher, parent, student, and administrator.

Computerized Bulletin Boards

Computerized bulletin boards (CBB's) are also being employed in special education as a method of communicating with the handicapped, their parents, teachers, and program administrators. One such CBB is SpecialNet, which for a nominal fee, provides information about special education books, programs, training, legislation, and technology. Another CBB, which answers telephone messages through a MODEM, is the Handicapped Educational Exchange (HEX). HEX is a clearinghouse for information on the use of technology to aid the handicapped. It also demonstrates how inexpensive home computers can be used to provide message exchange systems for the deaf (Barth, 1982). Messages from this CBB come in three forms—information files, databases, and telephone messages. HEX was developed by the American Radio Research and Development Corporation (AMRAD) located in Washington D.C.

TODAY AND TOMORROW

Initial exploration of microcomputer use has already touched every exceptionality. The technology is here but the application is still in its infancy. Much is still experimental; much requires an abundance of equipment and is extremely expensive. As Cushman (1981) stated in her article regarding one corporation developing systems for the handicapped, they are "still working on improvement and hope to reduce the machine to the size of a briefcase at a cost no more than an automobile" (p. 145). In time it is expected that much of the equipment will cost no more and be no larger than a pocket calculator. In the meantime, the knowledge of what has been developed and the creative imagination special educators have used so far should be the catalyst for change in the immediate future.

Developments beyond our comprehension will probably occur in the next 20 to 30 years. There will be more disk sharing or network systems. There will be video disc systems that will combine the capabilities of the microcomputer. Using these capabilities, they will combine movies, slides, and instant television to allow students to enter simulated experiences to go back into time, ahead into time and space, and actually experience events as they are happening thousands of miles away. To experience all of this, the student will not have to leave home but will receive and input information into a home computer interfaced with a television set.

The school of tomorrow may not be as we know it today. Student scheduling will be flexible, with teachers coordinating information, developing programs, and working with small groups of students for discussion and experiential purposes. Students will also be able to interact with other students around the world. Experts and resources will be as close as your fingertips.

Handicaps may no longer be disabling. The six million dollar man may become a reality—virtually eliminating the disability caused by the handicap. Already, medical science is developing a tiny computer that can fit into a vein to regulate the amount of insulin injected into the blood stream of the diabetic. Educators will be able to analyze learning problems and be able to get an IEP based on a pool of information and plans designed by experts around the world. A program will synthesize all information—from teachers, student, parents, physicians, and social services specialists.

For Discussion

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1. *List the needs of handicapped individuals and, across from each need, list possible ways to meet those needs, especially considering the technology available today.*
2. *List and discuss all ideas for further uses of the computer (e.g., satellite networks in the home combining video disc with computer for interactive purposes; minute computers that can be placed within the body to help people to talk, to physically move their bodies, to inject medication as the body requires, or to provide positive reinforcement for acceptable behavior).*

SUMMARY

This chapter has explored some of the current microcomputer uses for exceptional individuals. It has also presented some ideas on uses that can be and are being developed. Where are we going in special education? The answer is up to all of us. It's exciting to think that the goal of individualized education is in sight not only for special education but also for all education. Total individualization in education is possible. It's also exciting to know that an ounce of technology and a pound of ingenuity added to an Apple a day could help many Johnnys and Joans grow and develop into self-sufficient adults.

Activities and Further Discussion

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1. *In an earlier chapter, you were asked about education in the future. Using your wildest imagination and the knowledge you now have about the microcomputer, what will education be like in 40 or 50 years?*
2. *If you had your way, what changes could you make in education to individualize for the handicapped population under your jurisdiction? Include changes both in the special education classroom and in the mainstreamed setting focusing on further implementation of the philosophy of "least restrictive environment."*

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CHAPTER 6

Elementary Programming for the Microcomputer

As You Read This Chapter, Think About:

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1. *What an authoring system is and how it would or would not be of benefit to you.*
2. *What the educational process is in developing an educational microcomputer software program.*
3. *How to program information (text) and questions.*
4. *How to further develop the programming skills necessary to program software and/or where to obtain assistance and support.*
5. *The best method for you to follow in developing software at the present time (e.g., BASIC, authoring system, etc.).*

INTRODUCTION

This chapter will introduce the reader to various methods by which educators with little time or expertise in computer programming can begin to understand the programming process. It is also designed to stimulate further learning through courses, books, workshops, inservice presentations, and independent experimentation on the microcomputer. Advanced programming takes years of study and experience, but by the end of this chapter, you will be able to write relatively simple but educationally sound programs.

It takes hours, hours, and more hours to create educationally and technically sound complex programs. According to Braun, "The cost to develop just one good—repeat, good—program is roughly $10,000–$12,000 and that's assuming a 'not-for-profit' producer" (1981, p. 36). The implication is that the educator can do some programming, and certainly should. The educator should be able to program relatively simple computer managed drill and practice programs and tests and relatively simple computer managed concept instruction programs, and data management programs. Furthermore, the educator should be able to modify some programs—although not many commercial producers allow the consumer to make changes because of their fear of piracy and the possibility of putting "bugs" into complex programs that will keep them from running.

This chapter first discusses authoring languages and systems and follows with an introduction to programming using an educational model and the BASIC language. The final section suggests some sources for funding to assist the creative educator in programming unique software and in developing or modifying hardware for handicapped individuals.

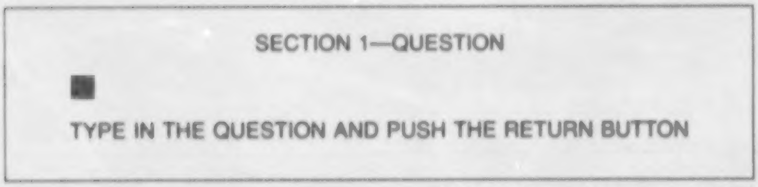
AUTHORING SYSTEMS

One way for educators to develop their own programs is by using an authoring language or system. These are software programs, designed to assist the novice programmer in formulating programs. Authoring languages include such programs as Planit, Tutor, and Pilot. Authoring systems require even less programming knowledge and include systems such as Ticcit, Genis Courseware Development System, Blocks, and GraForth II. Authoring systems, unlike authoring languages, do not have command statements but include a built-in logic. The educator needs only to fill in the presentation, questions, answers, feedback, and brief remediations for student mistakes.

One of the simplest authoring systems to use is LOGO, which was developed specifically for elementary age students but has even been used with preschoolers. The system uses turtle graphics, which involves a symbol, shaped like an arrowhead, called a "turtle." Based on the directions given, the turtle moves around the screen, leaving a trail behind it. A child can draw geometrically complex figures by directing the turtle's movements.

Another authoring system on the market was created for the Apple microcomputer by the Bell and Howell Company. This disk-driven system is called GENIS I, which is an acronym for Generalized Instructional Systems and is composed of two interrelated software systems called CDSI (Courseware Development System) and MARK-PILOT. In gen-

FIGURE 6.
GENIS I example.



```
                    SECTION 1—QUESTION

■

TYPE IN THE QUESTION AND PUSH THE RETURN BUTTON
```

(Bell & Howell Company, 1979)

eral, CDSI presents information, judges the responses, and provides corrective feedback, while storing into memory the responses made by the student. The student can make three mistakes and get "TRY AGAIN" on the screen. Then the answer is given. An example of the simplicity of the program is given in Figure 6.

With MARK-PILOT the commands are primarily based on the alphabet. For example, *T* stands for text, *A* stands for answer, and *M* stands for matching the student response with one previously selected by the teacher. A menu presented on the screen allows the user to see a catalog of current exercises, obtain the results from an exercise, change or delete an exercise, create or modify the student's program or create a new presentation or test (Bell & Howell Company, 1979).

Another authoring system, GraForth II, also uses turtle graphics with directions that have the turtle TURN and MOVE. This system creates not only flat surface graphics but also three-dimensional graphics. It is programmed for the Apple II and Apple II Plus.

One additional system, which will be briefly covered, is the Blocks II Authoring System, also available for the Apple II microcomputer. In addition to the usual graphics directions, this system creates graphics using game paddles, joysticks, or the Apple Graphics Tablet. It allows for high resolution graphics that include text and tables to be printed on the screen at the same time. The program not only permits the teacher to program text and questions but also provides a system to check on the student's responses.

AUTHORING LANGUAGES

Authoring languages are more complex than authoring systems, but they are still relatively easy to use. PILOT is probably the most well-known authoring language—whether it be Apple Pilot, Atari Pilot, or TRS-80 Pilot. PILOT is an acronym for Programmed Instruction, Learning Or Teaching. Commands used in PILOT include TYPE, ACCEPT, MATCH, COMPUTE, JUMP, and USE. The TYPE command permits text to be displayed on the screen. The ACCEPT command causes the microcomputer to wait for a response to be entered. The MATCH command sets up the parameters for the response to be considered as correct or incorrect. The COMPUTE command places numeric or string values into variables and evaluates the mathematical expression (allows for mathematical calculations). The JUMP command allows for branching or sending the program to specific locations in the program. The USE command tells the computer to execute subroutines or miniprograms within the main program.

If authoring languages are used, several specific guidelines should be followed:

> 1. Design the screen displays so they are easy to understand. . . .
> 2. Have the student respond frequently. . . .
> 3. Plan for wrong answers. . . .
> 4. Check for inappropriate answers. . .
> 5. Use branching so students having problems with a lesson do not become frustrated with questions they cannot answer and students who know the material do not become bored with material that is too easy.
> 6. Use color, graphics, and sound to convey information, reinforce students or draw attention to important information. Avoid extras that . . . distract from important information. . . .
> 7. Be . . . concerned with the student's learning. (Kleiman & Humphrey, 1982, p. 38)

Authoring languages and systems can be especially helpful to the educator. On the other hand, they lack flexibility and should be thoroughly evaluated as to whether they have the capabilities required for specific uses. They should be easy to learn and easy to use. Instruction manuals will help you make these determinations. Obviously, other areas that are applicable in the evaluation of software should be included, such as the cost and backup policy.

One last caution: "Authoring systems reduce cost and effort by reducing variety in much the same way that cost and effort are reduced in fast food restaurants" (Merrill, 1982, p. 77). That does not mean you should not buy them. It does mean that you should understand what they can and cannot do.

It is not the intent of the author to convince the reader to use these systems and certainly not to avoid learning programming skills, but to provide introductory information that can help in the comprehension of programming. In fact,

> Many teachers find computer programming a fairly easy skill to learn. Elementary computer programming does not require expertise in mathe-

> matics or computer technology. The process of creating a computer program is, in fact, parallel to creating a lesson plan. Like lesson plans, computer programs are sequentially structured, with one idea building on earlier concepts. Translating the lesson or sequence into a computer language is no more difficult than learning how to communicate to students. (Sokoloff, 1981, p. 16)

For Discussion

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1. *Discuss reasons why the educator should have some basic knowledge in computer programming.*
2. *What are some of the advantages and disadvantages to authoring systems and/or languages?*
3. *What skill(s) do educators have that are also necessary for computer programming?*

EDUCATIONAL COMPONENT OF SOFTWARE DEVELOPMENT

Creating an effective educational computer program using BASIC or any computer language requires the combined effort of educational and technological expertise. The educator needs to understand the technological capabilities of the microcomputer and the programmer needs to have an understanding of the educational principles and the population for whom the programs are being written. With the importance of this understanding on the part of the educator and programmer in mind, the rest of this chapter is written for the educator who has limited knowledge in the area of programming.

There are a number of steps in the designing of a software program which should be followed in order to assure educational effectiveness:

1. Define the problem, establish the goal, and develop instructional objectives.
2. Develop an outline designed to teach each of the concepts as established in the objectives.
3. Print exactly what will be seen on each frame.
4. Develop an educational flowchart.
5. Edit for content, flow, errors, and continuity.

6. Work closely with the programmer or, if programming yourself, obtain advice as necessary to make optimum use of the capabilities of the microcomputer.
7. After programming, do final edits to check on the same factors as indicated in number 5 as well as to make sure there are no problems in the running of the program.
8. Develop the documentation.

Define Problem, Goal, and Objectives

The first step in developing educational software should be to define the problem, establish the goal, and develop the instructional objectives.

Develop Outline

The second step is to establish a sequential outline indicating exactly how each concept will be developed and in what order. Each concept should be introduced, sequentially presented with appropriate examples, and summarized. An evaluation section should follow the summary. The user should be required to input information that indicates that he or she has understood the concept. The program outline should indicate what the appropriate response on these frames should be and how the program will handle correct, incorrect, and inappropriate responses. Inappropriate responses indicate the user did not comprehend the directions (e.g., typing something other than *Y* or *N* on frames requiring *Yes* or *No* responses). It is a good idea to indicate in the outline how much of a response will be considered correct (e.g., *Y* for *Yes* or *INC* for *Income*). There is no need to have the machine check the complete typing of a word unless the program's goal is to increase spelling and/or typing skills.

Print

The third step is to print exactly what the screen will display in sequential order frame by frame. This involves a number of considerations:

1. Try to limit the number of lines on one frame (what you see on the screen at one time) to five or six lines. These lines should be

double-spaced for ease of reading. For some students you may want to have less than five or six lines, depending on the ability of the student to handle the information.

2. The number of spaces going across the frame is also limited. Usually, you will limit the spaces used to 37 or 38. The number of spaces you can use is machine dependent. It is important to remember that every space must be counted—not just the letters. For example,

     LIMIT YOUR SPACES.

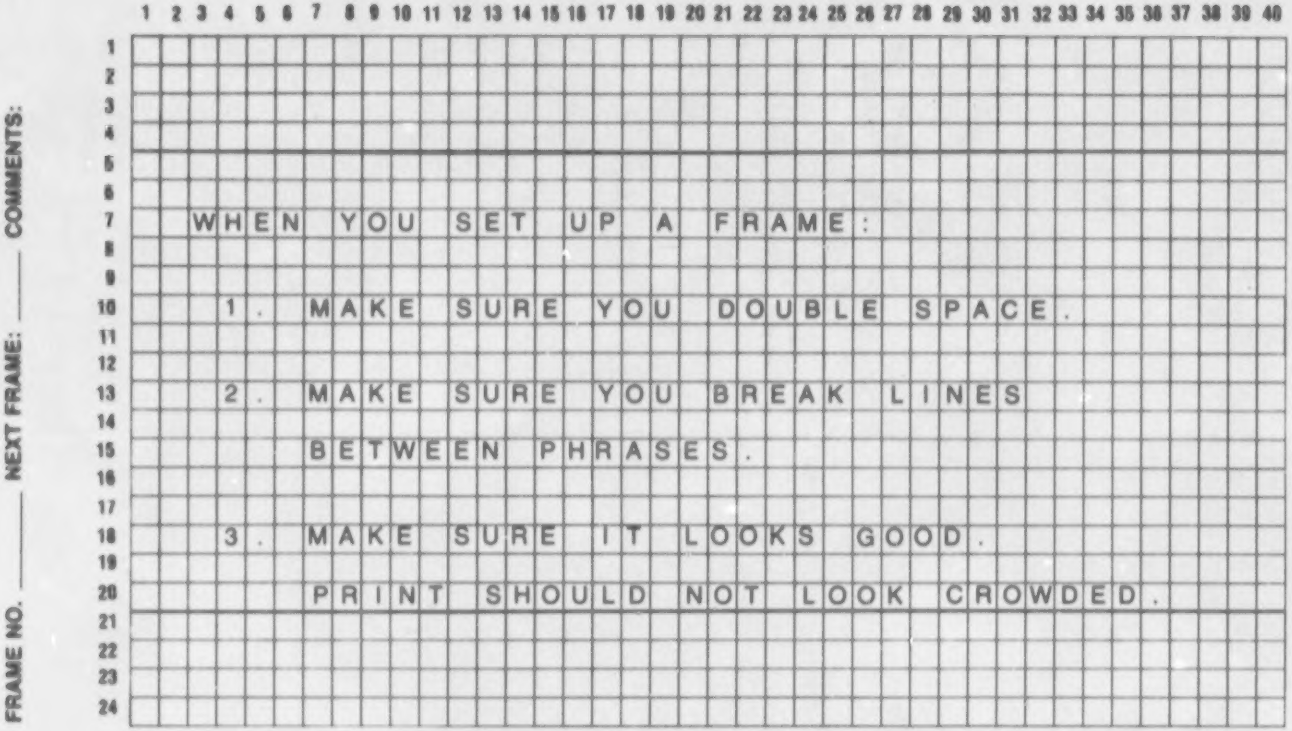
   takes up 23 spaces because the line is indented 5 spaces, there is a space between each word, the punctuation takes up 1 space, and the letters take up 15 spaces.

3. How you place the information on the screen is also important. Information should be organized so that it will be best understood by the learner. For example, try to avoid breaking lines in the middle of prepositional phrases.

4. Blinks, flashes, and inverse print can be used as attention getting and retention devices. A blink makes a word go on and off the screen a specified number of times. A flash continues until the frame leaves the screen. This author has found these two options to have limited benefit, however, because flashes and blinks are distractions. Therefore, their use should be carefully considered. Inverse print, however, has been very beneficial in highlighting new vocabulary or important terminology. Inverse print means that the print is black on a white background as opposed to the usual white on a black or green background. Two extra spaces are taken up when inverse print is used, one at the beginning of the inverse and one at the end. The space at the right end could also include the punctuation mark.

5. Graphics can be used. For example, with Apple-soft and low-resolution graphics, you can color in the squares or spaces you would be using with a choice of 13 colors (Apple II) at the top of the frame, leaving three lines at the bottom of the frame for any text or words you want to add (two lines if you double-space). Remember, you are coloring square spaces so your creativity is often tested—especially if you want to have a shape appear curved. Ordinary graph paper can be used for designing frames. Examples of a text and graphics frame are presented in Figures 7 and 8. Room should be left for noting frame number, how much of a response is to be considered correct on question frames, what frame to "GOTO" if a response is correct, if a response is not correct, and if a response is inappropriate.

FIGURE 7.
Educational programming form: Text example.



FRAME NO. _____ NEXT FRAME: _____ COMMENTS:

WHEN YOU SET UP A FRAME:

1. MAKE SURE YOU DOUBLE SPACE.

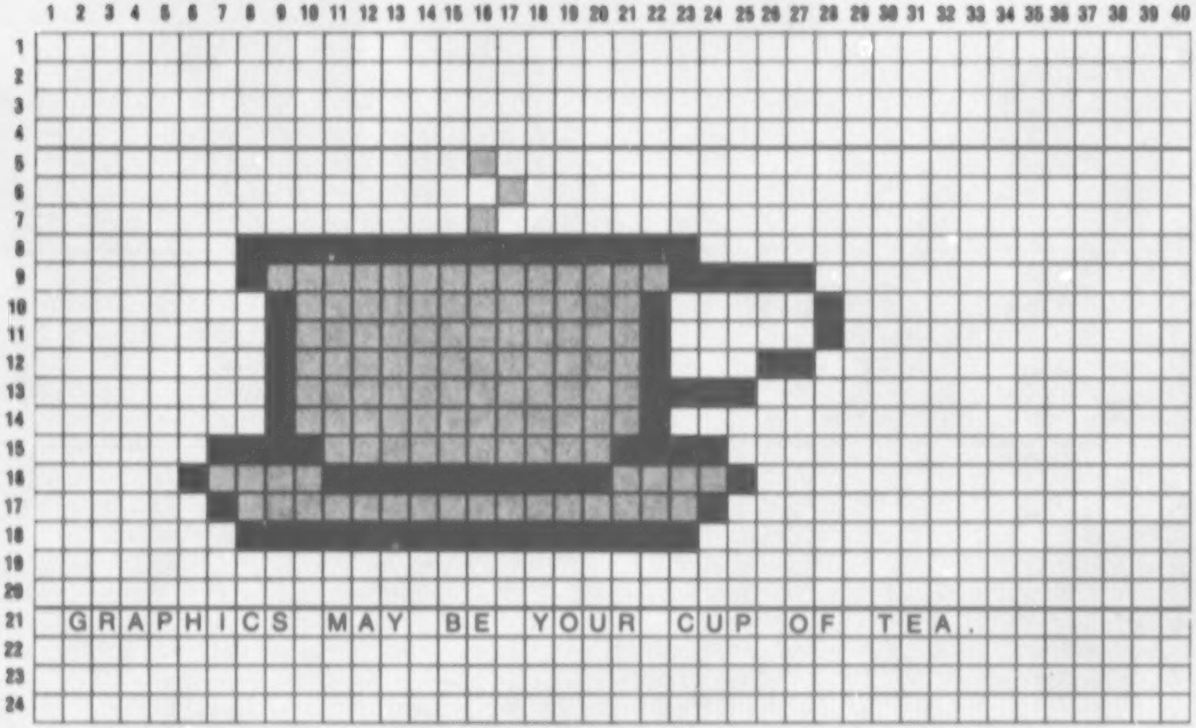
2. MAKE SURE YOU BREAK LINES
BETWEEN PHRASES.

3. MAKE SURE IT LOOKS GOOD.
PRINT SHOULD NOT LOOK CROWDED.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

FIGURE 6.
Educational programming form: Graphics example.

FRAME NO. ______ NEXT FRAME: ______ COMMENTS:



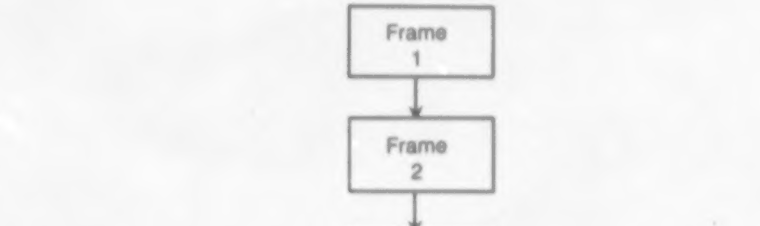
GRAPHICS MAY BE YOUR CUP OF TEA.

Develop Educational Flowchart

Step four involves a method by which the programmer, either the educator or someone else who can do programming, can determine the exact order for typing in a program. It is a road map to follow while programming. This is especially important following question/interaction frames because more than one path may be taken depending on the user's response. This method or road map is called an educational flowchart. An example of a simplified educational flowchart is shown in Figure 9.

In programming the software shown in Figure 9, each frame must be typed in in the order the frames are to be seen by the user. In following

FIGURE 9.
Simplified educational flowchart.


Frame 1
Frame 2
Frame 3
Info. on ans. Q 5
Inappropriate response
Frame 4
Wrong
Frame 6
Right
Frame 7
Frame 10
Frame 8
Frame 11
Frame 9

the arrows, it is noticed that three arrows come from the question or diamond shaped frame (frame 4). Within the computer program, directions must be given to the computer based on evaluation of the learner's response to the question.

Every conceivable response must be considered; otherwise, when the program is run and an alternative not covered is typed, the computer will stop running the program and an error message will appear on the screen. Therefore, if the learner or person running the program's response is correct on frame 4, the program will proceed to frame 10. If the response is whatever the computer is programmed to accept as wrong, the computer goes to frame 6—then 7, 8, and 9 for reteaching the concept before it rejoins the main part of the program. If the response is not evaluated as correct or incorrect, then the program goes to frame 5 where further instructions are provided to the learner on how to respond to the question. Unless you tell the computer otherwise, if the learner continues to type an inappropriate response, the computer will continue going to frame 5 and then back to frame 4. This is called a continuous loop. There are ways to tell the computer to only go through the loop once and then consider subsequent inappropriate responses as wrong (or go to frame 6).

Frame 10 should be a reinforcement frame that indicates to the learner that the response is correct and that he or she is doing a "good job." On the other hand, frame 6 should not be a punishing frame but should be encouraging and reinforce "trying."

Edit

Step five calls for the program, which is still in script form, to be proofed and edited. In going over the frames, the editor should not only check for spelling, grammar, sentence structure, syntax, and punctuation but also for context and the "flow" of the program. This is especially important in writing a computer program because of the various directions a program can branch to from one point. Any directions for programming should also be checked because nothing should be taken for granted except for rules established earlier by the writer and programmer (e.g., how many letters are needed to determine if a response is correct).

While editing the program, it is also a good idea to follow through the flowchart at the same time to make sure the frames and the flowchart go together and to make sure every frame leads to another frame until the ending frame is reached. After the writer is comfortable with the program, it should again be proofed and edited by someone else who has knowledge of the subject matter and some familiarity with writing computer programs.

Work with Programmer

Step six indicates that the writer and programmer should work together closely so that the programmer may make suggestions to the writer on how to make better use of the microcomputer during both the writing and programming stages. The writer should also be available during the programming stages to answer questions about formatting what is seen on the screen, and so forth. This step, of course, is only necessary if the writer and programmer are two different people.

Perform Final Edits

Step seven requires further proofing and possibly editing after the software has been programmed. The proofing at this point should take two forms, if a printer is available. It should be proofed by running the program to be sure it will run to completion regardless of what paths are taken according to the flowchart and regardless of what is typed in on the input frames. In other words, make sure the program is "user-proof." Besides running the program, proofing should involve reading through a printout to catch any errors that might have been inadvertently missed.

Develop Documentation

Step eight calls for developing documentation. The documentation should tell the user how to run the program, list the goals and objectives, describe the program, and discuss anything else the user (student and teacher) will need to know to make the best educational use of the program. This step is especially important if "swapping" of programs occurs.

Next Steps

In this section of Chapter 6, the reader has learned the foundations of the educational component in the creation of a microcomputer program. Before attempting to write a program, however, the reader may wish to review the evaluation form discussed in Chapter 2—especially as it relates to educational principles.

After the program is exactly the way the educational developer wants it to be, in other words the first five steps have been followed, the computer programming can begin. This programming can be done by the educator or it could be presented to someone else who has the technological capability. For example, students in computer programming classes, other teachers, or computer programmers hired by the school system for that purpose could do the actual programming—if the educator does not have either the expertise or the time to do so.

For Discussion

1. *Why is the educational component necessary for the development of effective educational software?*
2. *Name and describe the eight steps in the educational component of software development.*
3. *Establish the objectives for a simple program and then create an outline, text, and educational flowchart for one concept from the subject of your choice.*
4. *Create one low-resolution graphic including two lines of text on paper (using a grid form found in Figure 8).*

PROGRAMMING COMPONENT OF SOFTWARE DEVELOPMENT

NOTE: While reading this section, it is suggested that the reader stop frequently and create a few lines of program to practice the various directions, statements, and commands as they are presented.

Now that you know how to complete the educational component of software development, you need to learn how to technically program that educational component. Although the discussion will center around the Apple II, it can be generalized to other microcomputers. For example, the RETURN key on the Apple has similar functions to that of the ENTER key on the TRS-80. Therefore, if you learn concepts on one machine, you can readily transfer that knowledge to other machines with the aid of the operations manual.

First of all, on any machine you need to become familiar with the keyboard. The letters on many machines, such as the Apple, are all upper case so you do not need to worry about whether the letters you are typing are in upper or lower case. When you use the shift key on certain letters, however, what is written on the top part of that key is typed.

You also need to be aware of two important facts about the keyboard. Make sure you type a *1* when you want the number one and not the letter *l* for number one. You must also be careful to type a 0 when you want a zero and the letter *o* when that is what you mean. The arrow keys are two other keys with which you should become familiar.

If you make an error while typing a line, you can use the backarrow key (←) to move back where you want to be. Then just type what you want that line to say from that point. You can also use the forwardarrow key (→) to move ahead without erasing any type. The spacebar is not only used for spaces as on a typewriter but can also be used to erase letters.

The RETURN key is used within a program to go on in the program. When programming, it is used to enter a line into memory. The ESC key means escape and in some programs allows the user to escape from a program.

Getting ready to program is dependent on your machine, and the preparation section of your operator's manual should be read carefully. After your machine has been turned on and the DOS (disk operating system) has been booted (read into memory) or a disk has been initialized, you will be ready to type in a program you can later save on a disk. But before you actually try to program or to look at a program, a number of keys and commands need to be presented.

The key words or directions for the computer that need to be understood for beginning programming on the Apple are:

- PRINT
- LET
- INPUT
- GOTO
- END
- IF . . . THEN
- FOR . . . NEXT

These key words are part of what is called a BASIC statement that gives directions to the microcomputer.

PRINT directs the computer to print a statement on the screen. If you want the statement printed right away, you just type:

```
PRINT "I LIKE APPLES."
```

After you type in the words that you want to appear on that line with quotation marks around them, then press the RETURN key to enter the statement into memory. Immediately,

```
I LIKE APPLES.
```

will appear on the screen. If you do not want a statement to appear on the screen right away, you can write it as a deferred statement. Deferred statements are also stored in memory and will be erased if you type NEW or turn off the machine. To write a deferred statement, you add line numbers to the beginning of the line you want printed:

```
1000 PRINT "I LIKE APPLES."
```

Obviously, if you want to wait before you put something on a screen, you need to tell the computer not only to hold the information but also to keep it in a certain order. This is done by numbering the directions you give to the machine. For example, the previous line about apples was numbered 1000. The next line you want in order might be 1010. Many programmers use line numbers which are 10 digits apart. This is done in case lines must be added between existing lines of the program. In other words, you can type in lines in any order you want, but the computer will execute them in numerical order. If you decide to add a line or two, there is no problem as long as you have left space for line numbers to be added. You can change lines easily, too. Just retype the line number and type how you want it changed. The last way a line is typed is the way the machine stores it. If you make a mistake on a line while you are typing it, you can use the backarrow key to go back and fix it.

LET is another direction that can be given to a computer—although on the Apple it is not absolutely necessary. LET tells the computer to store or assign data into memory. For example:

```
1110 LET A = 3
1120 LET B = 6
1130 PRINT A*B
```

What you will get on the screen is 18 because 3 × 6 = 18. The symbol * means multiply. We only got the answer because we did not use quotation marks.

INPUT is a direction that permits interaction between the program and the one who runs the program. When an input statement is entered, a ? appears on the screen and remains until the person running the program provides input. For example:

```
1110 PRINT "HOW OLD ARE YOU?"
1120 INPUT A
```

GOTO statements tell the computer to go to a specific line number and continue executing from the specified line. We could add a GOTO statement to the two previous lines:

```
1130 GOTO 1110
```

Now, after line 1130, the program will go to line 1110 as directed and run the sequence again. This program would run forever if something did not happen to stop it. This is an example of a continuous loop. We can add an IF . . . THEN statement which will stop the looping if a specified condition occurs. Consider this program:

```
1110 PRINT "HOW OLD ARE YOU?"
1120 INPUT A
1130 IF A<40 THEN GOTO 1180
1140 PRINT "YOU ARE AT AN AGE"
1150 PRINT "WHERE LIFE BEINGS."
1160 PRINT "HAVE FUN."
1170 GOTO 1200
1180 PRINT "YOU ARE TOO YOUNG."
1190 PRINT "LIFE BEGINS AT 40."
1200 END
```

Notice how the program controls which line comes next. If the program user types in any age less than 40, the program goes to line 1180 because of the IF . . . THEN statement on line 1130. If an age of 40 or older is typed in, lines 1140, 1150, 1160, 1170, and 1200 follow. Notice line 1200. You see an END statement. That tells the computer to stop: the program has ended.

The only other statement to be added at this point is a FOR . . . NEXT statement. A FOR . . . NEXT statement, or FOR-NEXT loop, tells the computer to do something under certain conditions and continue until those conditions are met. Here is an example:

```
1110 FOR N = 1 TO 5
1120 PRINT "HELP ALL STUDENTS"
1130 PRINT "BECOME SELF-SUFFICIENT"
1140 PRINT "ADULTS."
1150 NEXT N
1160 END
```

The FOR . . . NEXT statements tells the computer to print three different lines one right after the other five times before going to the statement that tells it what to do next—in this case to END.

These statements and others, that can be learned as experience in programming grows, tell the computer exactly what to do. In fact, if you make language errors in writing a program, it will tell you with an error statement and the line number where the error is located. If this happens, you can fix that line by typing LIST and the line number to see the way you programmed it. Then you can retype it correctly. Computers cannot think for themselves and can only do what they are told. They cannot point out errors in program logic, or make judgments or assumptions.

Now that you understand a few statements or directions using BASIC words the computer understands, there are a few commands about which you need to know:

LIST
NEW
RUN
CATALOG
LOAD
SAVE
DELETE
CTRL C
RESET

The command LIST was presented in the discussion of how to get a line back on the screen that previously was typed. The command LIST by itself allows the programmer to see all the lines that have been typed in consecutive order. It is a good idea to type this command before starting to program to make sure nothing is in memory that will disturb your programming. It is also a good idea to use this command to make sure what you have typed in is actually there and is the way you want it. If you only want to see one line, you also type LIST; but in this case, you type LIST and the line number (i.e., LIST 1110).

When you are getting ready to write a new program, the command NEW should be typed. Everything in memory will be cleared or erased to make sure old program line numbers do not accidentally get into your new program.

Then, to execute or run a program after keying or typing it, the command RUN is used. RUN tells the computer to run the program in memory as set up—not with the line numbers but following all the directions you have programmed.

Now assume that you have your programs stored on a disk. (Instructions on how to do this follow.) You decide you want to load one of these programs from the disk into the computer. First, you would type the command CATALOG and then press the RETURN key to obtain a menu or list of the programs on that particular disk. After you select a program and you want it to enter the machine's memory from the disk, type the command LOAD or RUN plus the name of the program. If you type LOAD, the program will load. LOAD only transfers the program from the disk and places it in the machine's memory. To get the loaded program to run, you must then type RUN. If you type RUN and the program name the computer will both load and run the program.

Next you will learn how to save and erase programs you have written. These directions are given to the computer through the commands of SAVE and DELETE. To keep or save a program by loading it into external memory, as onto a disk, you type SAVE plus the name of the program. To do this, be sure that the disk has previously been initialized using the DOS. When a new disk is purchased it is completely blank. Initialization places index marks electronically on the disk so that the computer knows where to store your program. DELETE works the same way as SAVE except that it erases a program from the disk. To erase or delete a program, simply type DELETE and the name of the program. If you create a program and SAVE it but later want to change it, you can do this by LOADing that program, retyping the lines you want to change, adding new lines, and erasing unwanted lines by just typing the line number and pressing the RETURN key. Then simply SAVE the program again using the same program name, and you have replaced your old program with a new corrected one.

When you are running a program and you want to stop it, there are two methods that you can use—CTRL C and RESET. If you press the RESET key, it's like starting from the beginning. If you use a CTRL C (Control C), the program stops and the line number where the program stopped appears on the screen. With CTRL C, you can continue the program where you left off by typing CONT for continue. To enter the Control C command, hold down the CTRL key and while holding it down, press the C key. Using the RESET key to stop programs can have undesired results. If it is pressed while information is being saved on the disk, for example, some of the data may be lost.

In this section of Chapter 6 you have learned some elementary programming. You can create a few programs.

For Discussion and Application

1. *List and define terms, directions (key words), and commands used in elementary computer programming. Space should be left for additions to this list.*
2. *Create a program that teaches one idea or subskill, using as many of the directions and commands as you can. Do not forget to use line numbers that are at least 10 digits apart. You may wish to use the program you wrote in the previous section of this chapter.*
3. *As you read the next section of this chapter, add terms, directions, and commands to the list you started in number 1.*

SAMPLE PROGRAM

To provide the reader with an example of an actual program, a sample program flowchart (Figure 10) and the program based on that flowchart (Figure 11) are included here. This program involves the branching

FIGURE 10.
Educational flowchart for sample program,
"What micros can do."

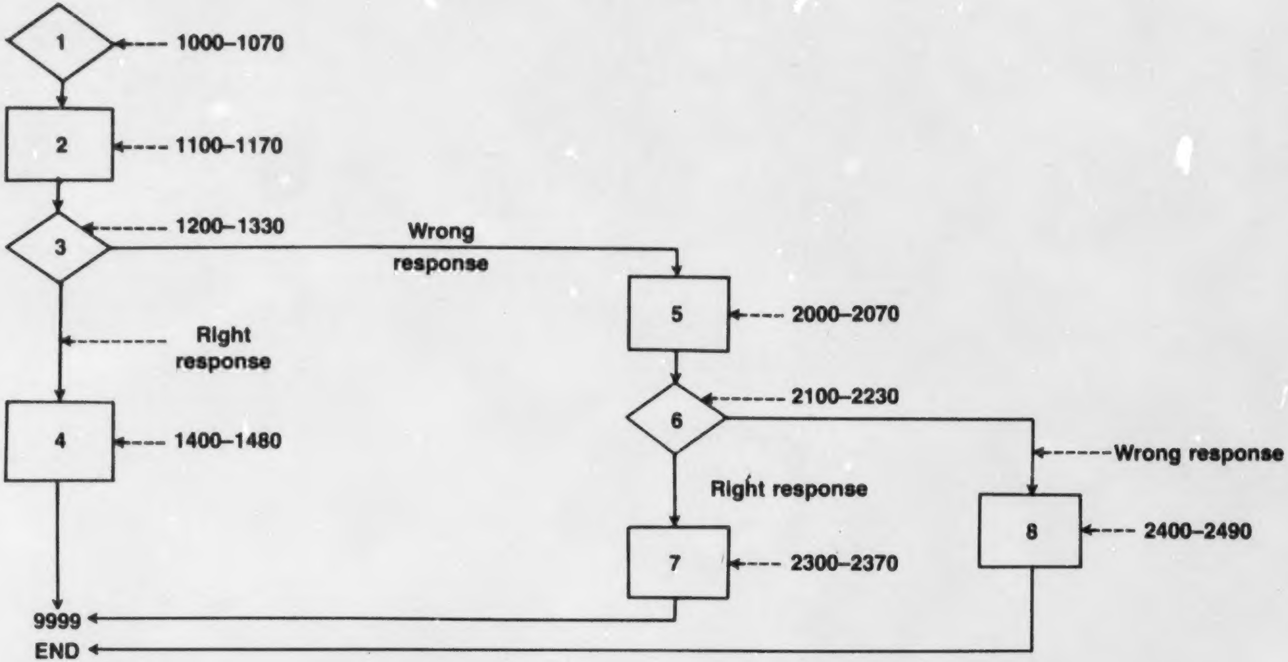
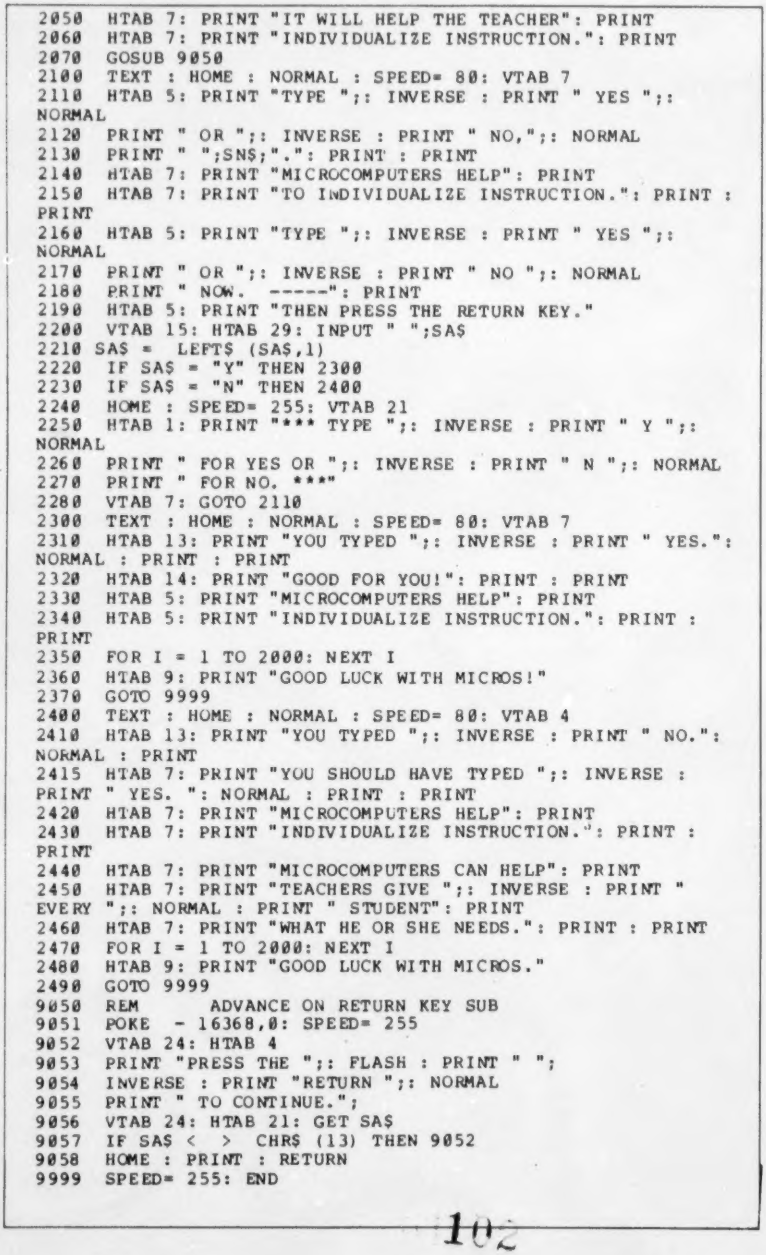

1
1000–1070
2
1100–1170
3
1200–1330
Wrong response
Right response
4
1400–1480
5
2000–2070
6
2100–2230
Wrong response
Right response
8
2400–2490
7
2300–2370
9999
END

FIGURE 11.
Sample computer program: "What micros can do."

```
100  REM     SAMPLE BRANCHING PROGRAM
101  REM     "WHAT MICROS CAN DO"
102  REM     DR. FLORENCE M. TABER
104  REM     PROGRAMMED 12 JULY 82
106  REM     APPLE II PLUS  48K  DOS 3.3
1000  TEXT : HOME : NORMAL : SPEED= 255: VTAB 9
1010  HTAB 10: PRINT "TODAY YOU WILL LEARN": PRINT
1020  HTAB 13: PRINT "ABOUT COMPUTERS.": PRINT : PRINT
1030  HTAB 1: PRINT "TYPE YOUR FIRST NAME NOW.
-------------": PRINT
1040  HTAB 1: PRINT "THEN PRESS THE RETURN KEY."
1050  VTAB 14: HTAB 27: INPUT " ";SN$
1060 SN$ =  LEFT$ (SN$,12)
1070  IF SN$ = "" GOTO 1000
1100  TEXT : HOME : NORMAL : SPEED= 255: VTAB 6
1110  HTAB 7: PRINT "A MICROCOMPUTER": PRINT
1120  HTAB 7: PRINT "IS A TOOL": PRINT
1130  HTAB 7: PRINT "THAT CAN HELP": PRINT
1140  HTAB 7: PRINT "THE TEACHER": PRINT
1150  HTAB 7: INVERSE : PRINT " INDIVIDUALIZE ";: NORMAL :
PRINT " INSTRUCTION": PRINT
1160  HTAB 7: PRINT "IN THE CLASSROOM."
1170  GOSUB 9050
1200  TEXT : HOME : NORMAL : SPEED= 255: VTAB 4
1210  HTAB 4: PRINT "WHICH OF THE PHRASES BELOW": PRINT
1220  HTAB 4: PRINT "BEST COMPLETES THIS STATEMENT:": PRINT
: PRINT
1230  HTAB 1: PRINT "THE MICROCOMPUTER HELPS THE TEACHER
--": PRINT : PRINT
1240  HTAB 4: PRINT "A. DO ALL THE TEACHER'S WORK.": PRINT
1250  HTAB 4: PRINT "B. INDIVIDUALIZE INSTRUCTION.": PRINT
1260  HTAB 9: PRINT "TYPE ";: INVERSE : PRINT " A ";: NORMAL

1280  PRINT " NOW.  -": PRINT
1290  HTAB 9: PRINT "THEN PRESS THE RETURN KEY."
1300  VTAB 16: HTAB 30: INPUT " ";SA$
1310 SA$ =  LEFT$ (SA$,1)
1320  IF SA$ = "A" THEN 2000
1330  IF SA$ = "B" THEN 1400
1340  HOME : VTAB 22
1350  HTAB 1: PRINT "** YOU MUST TYPE A OR B.  TRY AGAIN.
**"
1360  VTAB 4: GOTO 1210
1400  TEXT : HOME : NORMAL : SPEED= 255: VTAB 5
1410  HTAB 2: PRINT "YOU ARE RIGHT, ";SN$;".": PRINT
1420  HTAB 2: PRINT "THE MICROCOMPUTER HELPS THE TEACHER":
PRINT
1430  HTAB 2: PRINT "INDIVIDUALIZE INSTRUCTION.": PRINT :
PRINT
1440  HTAB 5: PRINT "LEARN ALL YOU CAN": PRINT
1450  HTAB 5: PRINT "ABOUT MICROCOMPUTERS": PRINT
1460  HTAB 5: PRINT "AND THEN USE THEM EFFECTIVELY": PRINT
1470  HTAB 5: PRINT "WITH HANDICAPPED INDIVIDUALS."
1480  GOTO 9999
2000  TEXT : HOME : NORMAL : SPEED= 80: VTAB 6
2010  HTAB 7: PRINT SN$", YOU CHOSE": PRINT
2020  HTAB 7: PRINT "A. DO ALL THE TEACHER'S WORK.": PRINT :
PRINT
2030  HTAB 8: PRINT "A MICROCOMPUTER WILL ";: INVERSE :
PRINT : PRINT : HTAB 14: PRINT " NOT ";: NORMAL : PRINT :
PRINT
2040  HTAB 8: PRINT "DO ALL THE TEACHER'S WORK.": PRINT :
PRINT
```

FIGURE 11 con't.



```
2050  HTAB 7: PRINT "IT WILL HELP THE TEACHER": PRINT
2060  HTAB 7: PRINT "INDIVIDUALIZE INSTRUCTION.": PRINT
2070  GOSUB 9050
2100  TEXT : HOME : NORMAL : SPEED= 80: VTAB 7
2110  HTAB 5: PRINT "TYPE ";: INVERSE : PRINT " YES ";:
NORMAL
2120  PRINT " OR ";: INVERSE : PRINT " NO,";: NORMAL
2130  PRINT " ";SN$;".": PRINT : PRINT
2140  HTAB 7: PRINT "MICROCOMPUTERS HELP": PRINT
2150  HTAB 7: PRINT "TO INDIVIDUALIZE INSTRUCTION.": PRINT :
PRINT
2160  HTAB 5: PRINT "TYPE ";: INVERSE : PRINT " YES ";:
NORMAL
2170  PRINT " OR ";: INVERSE : PRINT " NO ";: NORMAL
2180  PRINT " NOW.  -----": PRINT
2190  HTAB 5: PRINT "THEN PRESS THE RETURN KEY."
2200  VTAB 15: HTAB 29: INPUT " ";SA$
2210 SA$ =  LEFT$ (SA$,1)
2220  IF SA$ = "Y" THEN 2300
2230  IF SA$ = "N" THEN 2400
2240  HOME : SPEED= 255: VTAB 21
2250  HTAB 1: PRINT "*** TYPE ";: INVERSE : PRINT " Y ";:
NORMAL
2260  PRINT " FOR YES OR ";: INVERSE : PRINT " N ";: NORMAL
2270  PRINT " FOR NO. ***"
2280  VTAB 7: GOTO 2110
2300  TEXT : HOME : NORMAL : SPEED= 80: VTAB 7
2310  HTAB 13: PRINT "YOU TYPED ";: INVERSE : PRINT " YES.":
NORMAL : PRINT : PRINT
2320  HTAB 14: PRINT "GOOD FOR YOU!": PRINT : PRINT
2330  HTAB 5: PRINT "MICROCOMPUTERS HELP": PRINT
2340  HTAB 5: PRINT "INDIVIDUALIZE INSTRUCTION.": PRINT :
PRINT
2350  FOR I = 1 TO 2000: NEXT I
2360  HTAB 9: PRINT "GOOD LUCK WITH MICROS!"
2370  GOTO 9999
2400  TEXT : HOME : NORMAL : SPEED= 80: VTAB 4
2410  HTAB 13: PRINT "YOU TYPED ";: INVERSE : PRINT " NO.":
NORMAL : PRINT
2415  HTAB 7: PRINT "YOU SHOULD HAVE TYPED ";: INVERSE :
PRINT " YES. ": NORMAL : PRINT : PRINT
2420  HTAB 7: PRINT "MICROCOMPUTERS HELP": PRINT
2430  HTAB 7: PRINT "INDIVIDUALIZE INSTRUCTION.": PRINT :
PRINT
2440  HTAB 7: PRINT "MICROCOMPUTERS CAN HELP": PRINT
2450  HTAB 7: PRINT "TEACHERS GIVE ";: INVERSE : PRINT "
EVERY ";: NORMAL : PRINT " STUDENT": PRINT
2460  HTAB 7: PRINT "WHAT HE OR SHE NEEDS.": PRINT : PRINT
2470  FOR I = 1 TO 2000: NEXT I
2480  HTAB 9: PRINT "GOOD LUCK WITH MICROS."
2490  GOTO 9999
9050  REM      ADVANCE ON RETURN KEY SUB
9051  POKE  - 16368,0: SPEED= 255
9052  VTAB 24: HTAB 4
9053  PRINT "PRESS THE ";: FLASH : PRINT " ";
9054  INVERSE : PRINT "RETURN ";: NORMAL
9055  PRINT " TO CONTINUE.";
9056  VTAB 24: HTAB 21: GET SA$
9057  IF SA$ <  >  CHR$ (13) THEN 9052
9058  HOME : PRINT : RETURN
9999  SPEED= 255: END
```

concept, in which reteaching occurs if the correct response is not given on a question frame, no punishment is given for an incorrect response, and reinforcement is given when the response is correct. First a small amount of information is presented. Then the program continues with a question frame followed by two branches. The wrong answer side again branches when the concept is retested. Study the educational flowchart (Figure 10) which indicates the line numbers as well as the frame numbers.

Notice that the lines numbered 1000–1070 are included in the first frame in which input is required. The frame numbers within the geometric figures and the line numbers listed next to each frame represented by a geometric figure should help you as you read through the computer printout of the program. Also, as you read through the actual program, you may not be able to understand all of the statements and commands. Do not be concerned because some explanation about function remains to be presented. However, *before you finish reading this chapter, read through the program (Figure 11) and then refer to it as you read this section.*

The first few lines (100–106) are REM or remark statements. These do not show on the screen when the program is run. Lines 1000–1070 program the first frame. Line 1000 merely sets up the screen to display the information, the speed at which the print appears on the screen, and the line (VTAB 9) on which the printing is to start. You will notice that this occurs on the first line statement for every new frame. The HTAB and numbers that begin each line tell the computer on which space to begin the line. This convention is like a tab key on a typewriter. The colon is used to allow more than one statement per line. PRINT (without a message following it) tells the computer to print a null line which is like skipping a line. PRINT:PRINT makes the computer skip two lines. The input statement is located in the statement line 1050—although if you figured out the VTAB and HTAB (vertical and horizontal tabs), you would note that the answer needs to be typed after the command to type in a name. The name which is called SN$ tells the computer to accept a string of letters ($) which we will call SN so we can call it from memory later. Line 1060 describes this variable called SN$ and instructs the computer to only accept 12 letters starting from the left side.

When the name is typed in and entered with the RETURN key, the screen is wiped clean by the first line for the next frame (1100), the HOME command. A way to remember the HOME command is to think of going home to start again and wipe the slate clean.

As you read through the lines, you will note GOSUB 9050 in certain locations, for example line 1170. GOSUB 9050 means to GO to a SUBroutine or miniprogram starting at line 9050. This subroutine, lines 9050–9058, tells the computer to instruct the program user to PRESS

THE RETURN KEY. The RETURN in line 5098 tells the computer to go back where it left off in the main program.

The FLASH and INVERSE are directions to the computer to either flash a letter or word or to put specified letters/words into inverse print (black on white instead of white on black). The direction to the computer following either of these two statements is NORMAL which means to return to normal print.

On occasion, you will also see a semicolon. This symbol is used to tell the computer not to generate a carriage return and line feed.

With as much information as is found in this short program, it is obvious that programming is not difficult to understand. However, it is also obvious that it takes time. Although it took a few hours to write and program this example, it takes only a couple of minutes to run it—even when all answers to questions are typed incorrectly. Therefore, many educators may wish not only to do some programming themselves but also to have others, who have the time, do programming for them. Because of time and money constraints, the purchase of software is usually a necessity—especially if an educationally effective program has already been written that meets your specific needs.

For Discussion and Application

---

1. *List the frames by number found in "What Micros Can Do" and print out just what would be seen on the screen if that program were run. You may wish to use text forms such as those found in Figures 7 and 8.*
2. *Create a short program on paper, including both the educational and programming components. If possible, do this in a small group. If available, test the program on a microcomputer and correct any errors.*

PROGRAM DEVELOPMENT SUPPORT

Some educators are finding ways to extend their programming abilities and uses for the microcomputer by joining support groups, and exchanging programs through organizations like SOFTSWAP.

SOFTSWAP is an organization based on a project initiated at San Jose University. The organization is now located at the San Mateo County Office of Education. It functions through donations of public domain software. SOFTSWAP evaluates and refines programs received based on their program standards checklist. Then they sell the final program disks for a nominal fee. In fact, if you donate a program on a disk to them they will "send you any SOFTSWAP disk of your choice in return" (Lathrop, 1982, p. 48).

Other swapping of disks frequently occurs between friends, within user groups, and any other place where disks are available. One word of caution: Beware of programs where no documentation is available. Very good programs misused, not designed to meet your goals, or not designed for your audience, etc., will probably not be educationally effective for your intended purposes. In fact, they could have a detrimental effect. Therefore, if you are doing any swapping, free of charge or at minimal charge, evaluate the programs thoroughly and obtain documentation whenever possible.

Starting or joining a support group can be helpful to anyone interested in computers in education. These groups can extend your technical expertise by sharing solutions to problems and bringing updated information to the group. They can also be a way to share programs.

Funding is a concern for most educators. Occasionally, local philanthropic groups and corporations will fund educational institutions or endeavors if the project will benefit the community or a specific group, such as the blind.

There are other places to look for possible project funding. Several sources are available for women and minorities. Funding sources include computer organizations, federal agencies, and computer corporations. For example, "The Foundation for the Advancement of Computer-Aided Instruction (formerly the Apple Education Foundation), [which] is an independent foundation supported by more than 12 separate sources . . . [funds] instructional materials that promise to advance computer-aided instruction" (Sokoloff, 1981, p. 16). Johns Hopkins University has sponsored a contest for the development of programs for the handicapped. Advertisements requesting that proposals for funding be submitted are occasionally seen in computer magazines. Sources for funding are listed at the conclusion of this chapter.

For Discussion

1. *Knowing your own time frame and expertise, how would you create software or get it developed (i.e., do your own programming, write the educational component, hire a programmer, etc.) and where in your community could you seek assistance and support?*

2. *Make a list of persons in your community who might be interested or have shown an interest in creating or joining a software development support group.*

SUMMARY

Chapter 6 has provided information on programming, presenting simplified methods of programming, called authoring systems; through slightly more complex methods that use a few commands, called authoring languages; and a method that is a programming language, called BASIC. At this point the reader should be able to do some programming, but, probably more importantly, has obtained basic knowledge on the concept of program development.

In the last section of this chapter, information was provided to assist the educator in finding support systems, both financial and programming, in order to extend the capabilities of his or her programming and software library.

This entire book has been developed with the interests of special education in mind. It was designed to assist the educator in becoming "computer literate." You now know the basics about what a microcomputer is, how to develop effective software, and how to do some elementary programming. You know what some uses are for the microcomputer in education in general and in special education specifically. You have the information by which you can evaluate both software and hardware. You can make educationally and cost-effective decisions regarding the microcomputer in special education—to assist those individuals with handicaps to communicate and to live independently.

FUNDING SOURCES

AMP Block Grant Center for Media and Technology, 1101 Connecticut Ave. NW, Suite 700, Washington DC 20045, Phone: 202-857-1195

Apple Foundation for the Advancement of Computer Aided Instruction, 20525 Mariani Ave., Cupertino CA 95014, Phone: 408-996-1010 (Grants in the form of equipment for innovative ideas)

Artists in Education Program, National Endowment for the Arts, 2401 E St., NW, Washington DC 20506, Phone: 202-634-6028 (Theme: Arts in education)

Atari Institute for Educational Action Research, 1265 Borregas Ave., PO Box 427, Sunnyvale CA 94086, Phone: 408-745-2000 (Theme: New uses for computers in education)

The Carnegie Foundation for the Advancement of Teaching, 1785 Massachusetts Ave., Washington DC 20036, Phone: 202-387-7200 (Theme: Elementary and secondary equal opportunity education)

Commodore Business Machines, Inc., Valley Forge Square, 681 Moore Rd., King of Prussia PA 19406, Phone: 215-337-7100

Council of Foundations, Inc., 1828 L St., NW, Washington DC 20036 (Provides direction for funding sources)

DPMA-EF Fellowships, William Mitchell, University of Evansville, PO Box 329, Evansville IN 47702 (Grants to universities to retain faculty)

Educational Funding News, 752 National Press Building, 529 14th St., NW, Washington DC 20045

The Edward E. Ford Foundation, ℅ Manufacturers Hanover Trust Company, L. Hlavacek, Executive Director, 600 5th Ave., New York NY 10020, Phone: 609-921-1126 (Theme: Independent secondary school education)

The Ford Foundation, Howard R. Dressner, Secretary, 320 E. 43rd St., New York NY 10017, Phone: 212-573-5000 (Theme: Elementary and secondary education, especially roles of minorities, women, and parents in education)

The Foundation for the Advancement of Computer-Aided Instruction, 20863 Stevens Creek Blvd., Cupertino CA 95014

Fund for the Improvement of Post Secondary Education (FIPSE), Dr. Arturo Madride, FOB #6, Room 3123, 400 Maryland Ave., SW, Washington DC 20202

or

Brian Stacey, FOB #6, Room 2167, 400 Maryland Ave., SW, Washington DC 20202 (Theme: Indian education)

or

7th & D Sts., SW, Rm. 3100, Washington DC 20202

Hollins College, ℅ Barbara Kurshan, Hollins VA 24020 (List of sources for women and minorities in education)

The Howard W. Hazen Foundation, 400 Prospect St., New Haven CT 06511, Phone: 203-865-4121

Inmac Plus Sweepstakes, 2465 Augustine Dr., Santa Clara CA 95051 (Theme: Prizes for winning disk programs)

Interactive Sciences, Inc., Tom Sidebottom, Public Relations, 1010 Harriet St., Palo Alto CA 94301, Phone: 415-855-8259

National Diffusion Network Division, U.S. Department of Education, Rm. 802, Riviere Bldg., 1832 M St., NW, Washington DC 20036, Phone: 202-653-7000

National Endowment for the Humanities, Public Affairs Office, 806 15th St., NW, Washington DC 20506, Phone: 202-724-0256 (Theme: Arts in education)

National Science Foundation, Development in Science Education, 1800 G St., NW, Washington DC 20550, Phone: 202-282-7910 (Theme: Research, matching funds)

Tandy TRS-80 Educational Grants Program, Radio Shack Education Division 400, 400 Tandy Atrium, Fort Worth TX 76102 (Theme: Potential benefit to education)

Texas Instruments, Jim Dugan, Educational Marketing Specialist, M/S 5876, PO Box 10508, Lubbock TX 79408 (Theme: Computer usage in the classroom)

Topics: Computer Education for Elementary and Secondary Schools, Association for Computing Machinery, 1133 Avenue of the Americas, New York NY 10036 (ACM Order No. 812810, 1981)

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Special thanks: Spengler, G., & Andrews, G., MCE Inc., 157 Kalamazoo Mall, Suite 250, Kalamazoo MI 49007.